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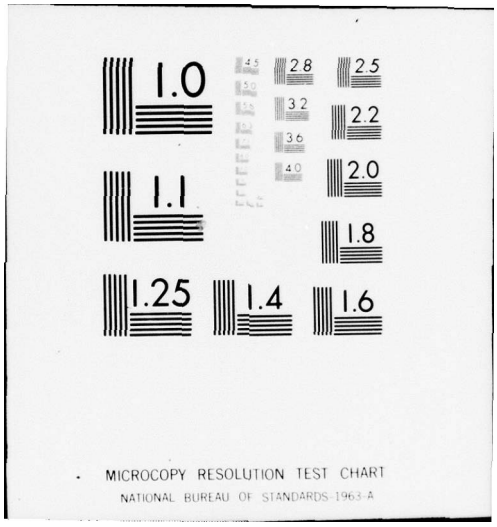
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SUPPORTING TECHNICAL REPORTS APPENDIX

ANNEX E - INFLOW/INFILTRATION - OMAHA

REVIEW REPORT ON THE MISSOURI RIVER AND TRIBUTARIES

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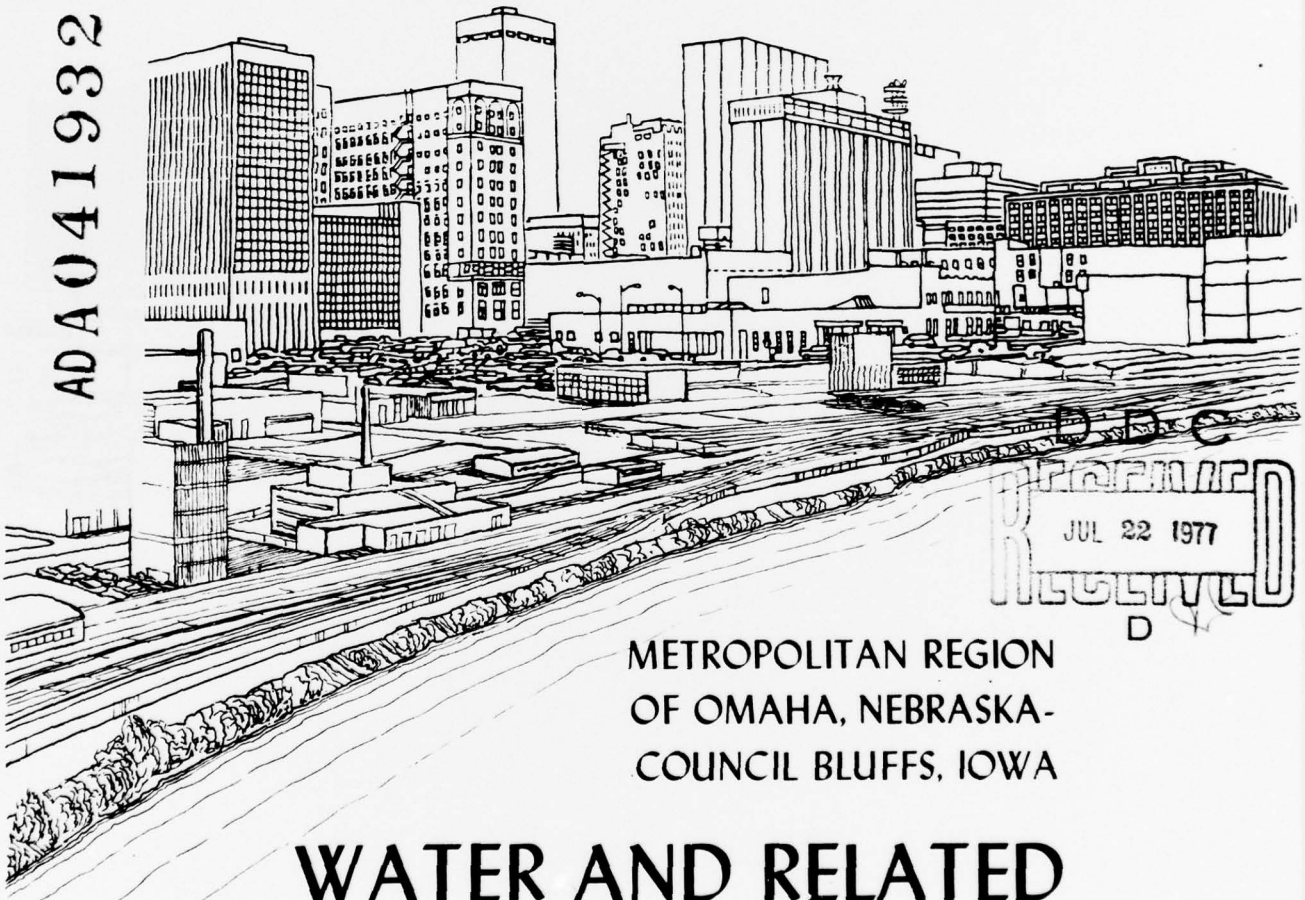


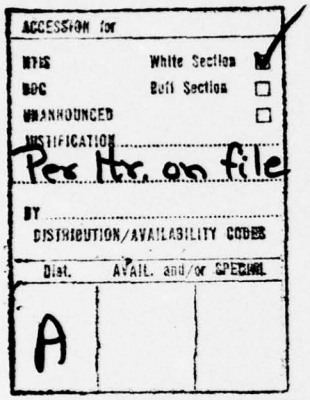
METROPOLITAN REGION
OF OMAHA, NEBRASKA-
COUNCIL BLUFFS, IOWA

WATER AND RELATED LAND RESOURCES MANAGEMENT STUDY

ORIGINAL CONTAINS COLOR PLATES: ALL DDC REPRODUCTIONS WILL BE IN BLACK AND WHITE.

JUNE 1975

REVIEW REPORT FOR



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Metropolitan

Omaha, Nebraska-

Council Bluffs, Iowa

Volume 5. Supporting Technical Reports
Appendix
Annex E. Inflow/Infiltration-Omaha.

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WATER AND RELATED LAND RESOURCES MANAGEMENT STUDY.

ORIGINAL CONTAINS COLOR PLATES: ALL DDC REPRODUCTIONS WILL BE IN BLACK AND WHITE.

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REVIEW REPORT FOR
METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA
WATER AND RELATED LAND
RESOURCES MANAGEMENT STUDY

Supporting Technical Reports Appendix

Annex E Infiltration/Inflow Analysis

PREPARED BY THE
OMAHA DISTRICT, CORPS OF ENGINEERS
DEPARTMENT OF THE ARMY

REVIEW REPORT FOR METROPOLITAN OMAHA, NEBRASKA COUNCIL BLUFFS, IOWA WATER AND RELATED LAND RESOURCES MANAGEMENT STUDY

Volume V Supporting Technical Reports Appendix

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ANNEX B	INTASA LAND USE PAPER
ANNEX C	URBAN STORMWATER HYDROLOGY STUDY
ANNEX D	URBAN STREET POLLUTANT ANALYSIS
ANNEX E	INFLOW/INFILTRATION - OMAHA
ANNEX G	AGRICULTURAL POLLUTANTS
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ANNEX J	ABATEMENT OF POLLUTION FROM COMBINED SEWER OVERFLOWS
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	REGIONAL WATER SUPPLY - APPENDIX
ANNEX L	INTASA RECREATION PAPER
ANNEX M	SINGLE PURPOSE LEISURE TIME ACTIVITIES

PREPARED BY THE

OMAHA DISTRICT CORPS OF ENGINEERS

DEPARTMENT OF THE ARMY

SECTION A

SUMMARY

SECTION A

SUMMARY

1. The wastewater flow from the area of Omaha, Nebraska that drains directly to the Missouri River receives treatment at the Missouri River treatment plant. This portion of Omaha is mainly served by a combined sewer system built in the early part of this century. This system empties into an interceptor system located close to the river; the interceptor carries the wastewater flow to the treatment plant except during periods of heavy rainfall or when mechanical failure occurs at the grit removal facilities and lift stations. When the flows in the sewer service areas reach predetermined values, the interceptor becomes overloaded and wastewater is discharged directly to the Missouri River.

2. The Omaha-Missouri River treatment plant provides primary treatment of wastewater, but secondary treatment facilities are being designed for construction in the near future. The present plans are to treat only the wastewater flows that should presently be diverted to the Missouri River treatment plant. Alternatives have been developed by Harza Engineering Company under the Corps of Engineers' Omaha Urban Study for treating the storm runoff flow presently being discharged directly to the river by a separate treatment facility. The city of Omaha also plans to provide some redundancy in its grit removal system in the near future to maximize system reliability so that all dry-weather flow will go to the Missouri River treatment plant.

3. After an extensive analysis of system flow conditions was made, the following pertinent information was formulated:

- Total measured dry-weather flow through the interceptor system amounts to 21.420 MGD.

- On an average basis, the dry-weather infiltration is 1.053 MGD for the entire system.

- Total average wet-weather flow, that is, runoff plus dry-weather flow to the sewer collection systems is 38.481 MGD.

- Of the total average wet-weather flow, only 24.181 MGD (62.8 percent) enters the interceptor system and the other 14.300 MGD is discharged directly to the Missouri River.

- The average flow through the Omaha-Missouri River treatment plant increases by only 2.761 MGD, (24.181 minus 21.420), an increase of only 12.8 percent over the dry-weather flow due to wet-weather runoff.

4. It was determined that excessive infiltration/inflow is not being discharged to the Omaha-Missouri River treatment plant even though a very large amount of inflow is entering the combined sewer collection system.

SECTION B

INTRODUCTION

INTRODUCTION

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SECTION B

INTRODUCTION

Purpose of the Study

1. The Federal Water Pollution Control Act Amendments of 1972 require all applicants for a treatment works grant after July 1, 1973 to perform, in conjunction with preliminary plans and studies, an analysis to determine the possible existence or non-existence of excessive infiltration/inflow in the applicant's sewer system.

2. Extraneous water from infiltration/inflow sources reduces the capability of sewer systems and treatment facilities to transport and treat domestic and industrial wastewaters. Infiltration occurs when existing sewer lines undergo material and joint degradation and deterioration as well as when new sewer lines are poorly designed and constructed. Inflow normally occurs when rainfall enters the system through direct connections such as roof leaders and catch basins. The elimination of infiltration/inflow by sewer system rehabilitation can often substantially reduce the cost of wastewater collection and treatment. A logical and systematic evaluation of the sewer system is necessary to determine the

cost-effectiveness of any sewer system rehabilitation to eliminate infiltration/inflow.

3. The city of Omaha plans to upgrade the Omaha-Missouri River treatment plant to provide secondary treatment. This expansion is required to meet a Federal requirement of secondary treatment by 1 July 1977. This report is intended to fulfill the infiltration/inflow analysis requirements necessary to obtain the treatment works grant.

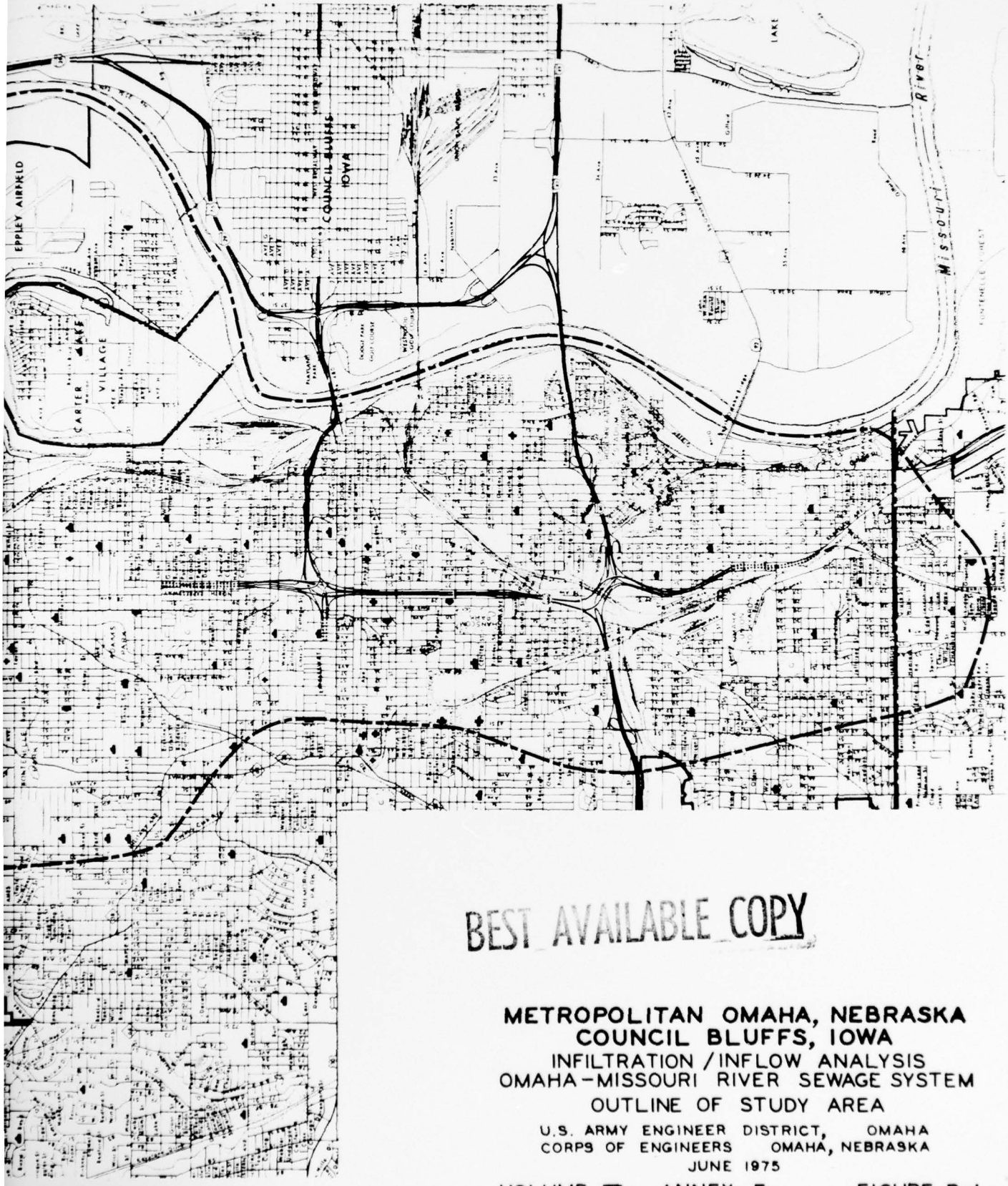
Area Included in the Study

4. Part of the city of Omaha is the planning study area. The boundaries are the west bank of the Missouri River opposite Council Bluffs, Iowa on the east; the Bridge Street sewer service on the north; the Monroe Street sewer service on the south; and Minne Lusa Street, Burt-Izard, and South Omaha service areas on the west. Figure B-1 shows the outline of the planning area.

5. A block flow diagram of the sewer system for the study area is shown as figure B-2. From this diagram, it can be seen that all sanitary flow is diverted to the main interceptor line to the Missouri River treatment plant except when storms or system malfunctions occur; then the flow travels directly to the river.

6. Following is a list of definitions of the technical terms used in this report:

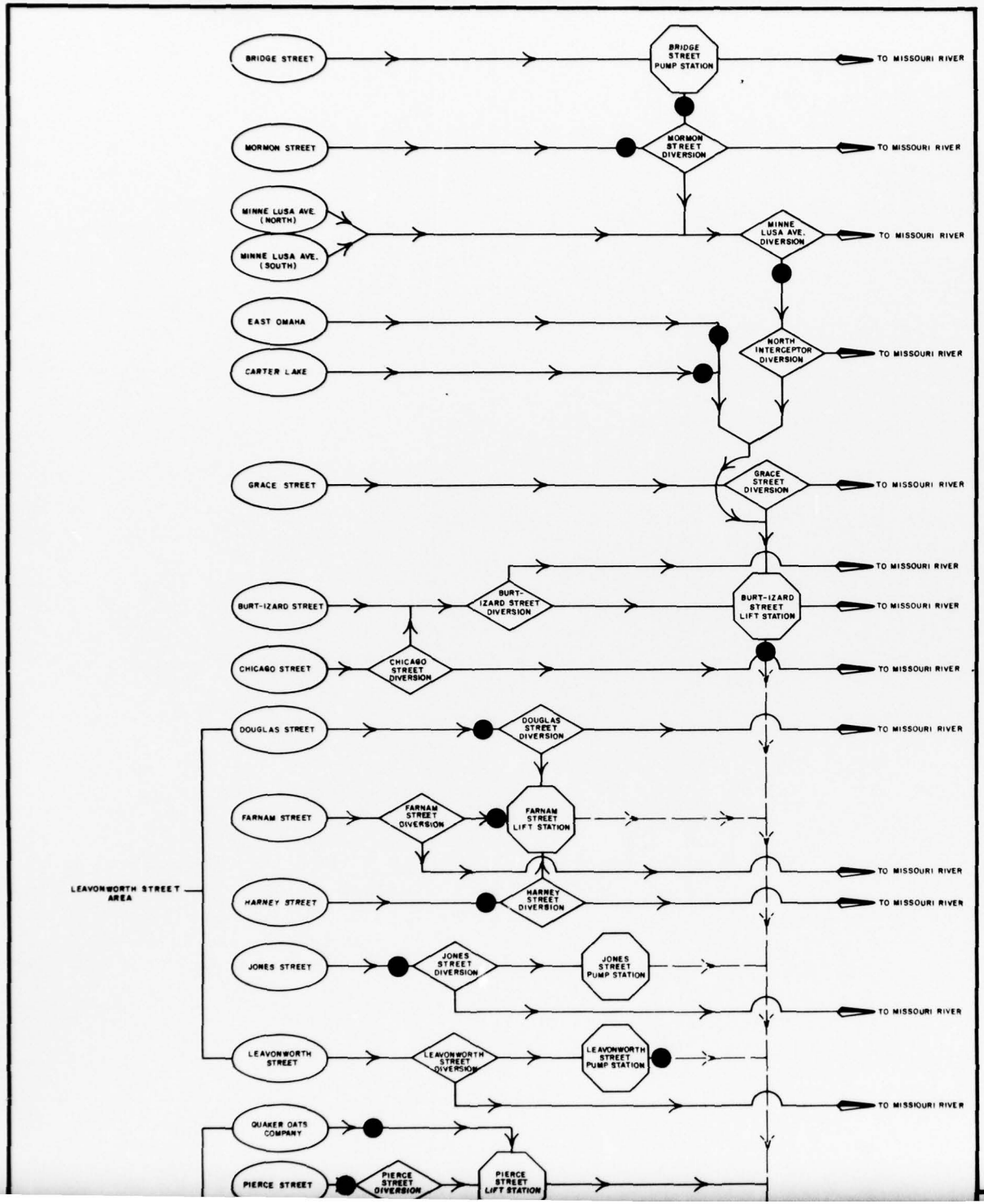

NORTH OMAHA AIRPORT
SKYRANCH AIRPORT
MEMORIAL PARK
OMAHA COUNTRY CLUB
FOREST LAWN CEMETERY
BENSON PARK
CARTER LAKE
EPPLEY AIRFIELD
CARTER LAKE VILLAGE
COUNCIL BLUFFS IOWA



METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA
INFILTRATION / INFLOW ANALYSIS
OMAHA - MISSOURI RIVER SEWAGE SYSTEM
OUTLINE OF STUDY AREA

U.S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA
JUNE 1975

VOLUME V ANNEX E FIGURE B-1


BRIDGE STREET
BRIDGE STREET PUMP STATION
TO MISSOURI RIVER
MORMON STREET
MORMON STREET DIVERSION
TO MISSOURI RIVER
MINNE LUSA AVE. (NORTH)
MINNE LUSA AVE. (SOUTH)
MINNE LUSA AVE. DIVERSION
TO MISSOURI RIVER
EAST OMAHA
CARTER LAKE
NORTH INTERCEPTOR DIVERSION
TO MISSOURI RIVER
GRACE STREET
GRACE STREET DIVERSION
TO MISSOURI RIVER
TO MISSOURI RIVER
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BURT-IZARD STREET DIVERSION
BURT-IZARD STREET LIFT STATION
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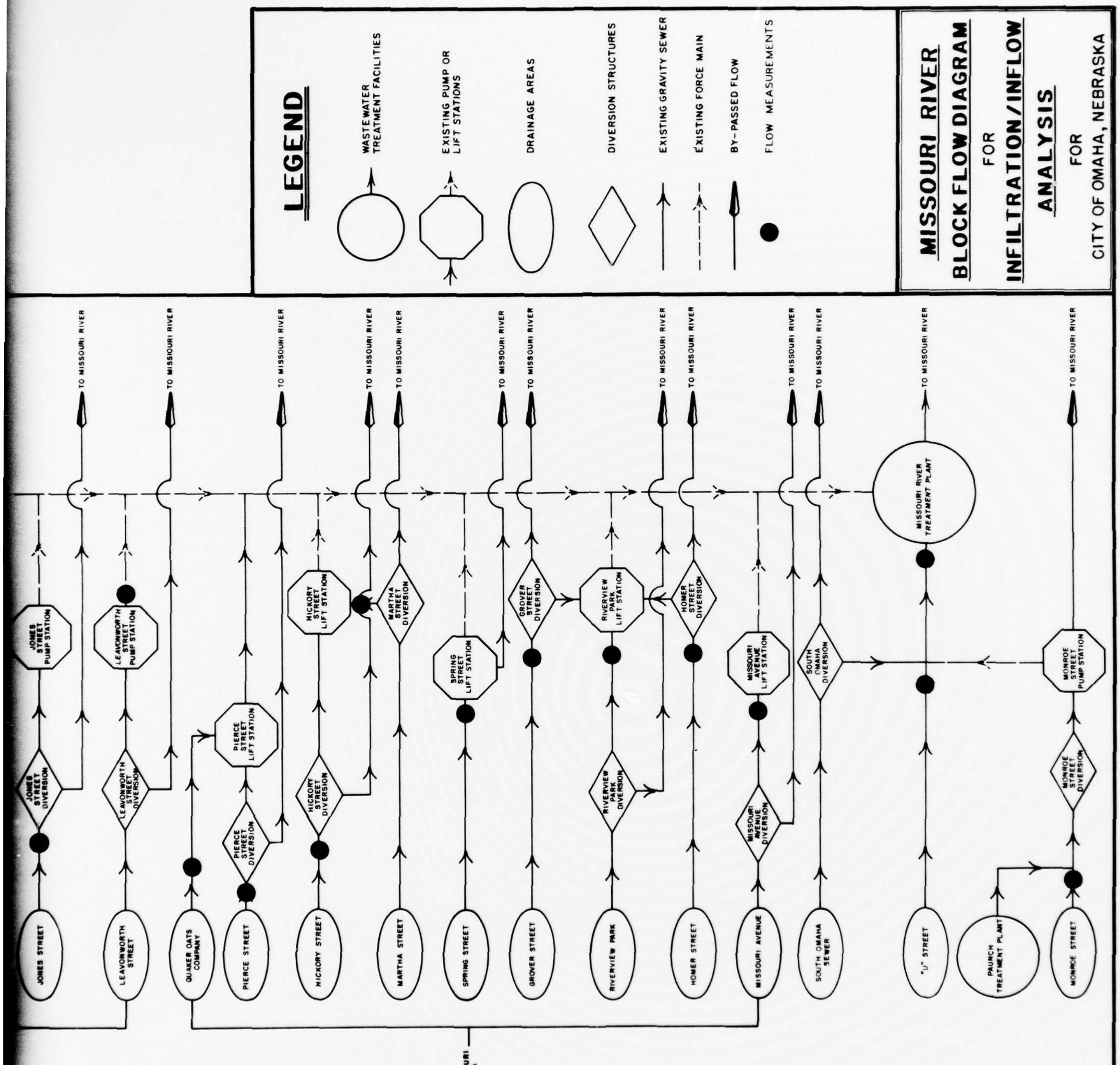
CHICAGO STREET
CHICAGO STREET DIVERSION
TO MISSOURI RIVER
DOUGLAS STREET
DOUGLAS STREET DIVERSION
TO MISSOURI RIVER
FARNAM STREET
FARNAM STREET DIVERSION
FARNAM STREET LIFT STATION
TO MISSOURI RIVER
LEAVONWORTH STREET AREA
HARNEY STREET
HARNEY STREET DIVERSION
TO MISSOURI RIVER
JONES STREET
JONES STREET DIVERSION
JONES STREET PUMP STATION
TO MISSOURI RIVER
LEAVONWORTH STREET
LEAVONWORTH STREET DIVERSION
LEAVONWORTH STREET PUMP STATION
TO MISSIOURI RIVER
QUAKER OATS COMPANY
PIERCE STREET
PIERCE STREET DIVERSION
PIERCE STREET LIFT STATION



METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA

INFILTRATION / INFLOW ANALYSIS
OMAHA-MISSOURI RIVER SEWAGE SYSTEM
MISSOURI RIVER BLOCK FLOW

U.S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA
JUNE 1975

Definitions

- Infiltration. The water entering a sewer system including sewer service connections from the ground through such means as but not limited to defective pipes, pipe joints, connections, or manhole walls.

- Inflow. The water discharged into a sewer system including service connections from such sources as but not limited to roof leaders; cellar, yard, and area drains; foundation drains; cooling water discharges; drains from springs and swampy areas; manhole covers; cross connections from storm sewers and combined sewers; catch basins; storm waters; surface runoff; street wash waters; or drainage. Inflow does not include and is separate from infiltration.

- Infiltration/inflow. The total quantity of water from both infiltration and inflow without distinguishing the source.

- Excessive infiltration/inflow. The quantities of infiltration/inflow that can be economically eliminated from a sewer system by rehabilitation. This is determined by a cost-effectiveness analysis which compares the cost for correcting the infiltration/inflow conditions with increasing the treatment works capacity to provide the required wastewater treatment for the quantities of infiltration/inflow.

- Sanitary sewer. A sewer intended to carry only sanitary or sanitary and industrial wastewaters from residences, commercial

buildings, industrial plants, and institutions.

- Storm sewer. A sewer intended to carry only storm waters, surface runoff, street wash waters, and drainage.

- Combined sewer. A sewer intended to serve as a sanitary sewer and a storm sewer or as an industrial sewer and a storm sewer.

- Dry-weather flow. Sum of water consumption and dry-weather infiltration/inflow.

- Wet-weather flow. Sum of dry-weather flow plus additional infiltration/inflow due to rain.

PREPARED BY THE

OMAHA DISTRICT CORPS OF ENGINEERS

DEPARTMENT OF THE ARMY

SECTION C

INFILTRATION/INFLOW ANALYSIS

INFILTRATION/INFLOW ANALYSIS

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INFILTRATION/INFLOW ANALYSIS

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INFILTRATION/INFLOW ANALYSIS

Geological and Geographical Conditions

SOILS

1. The Omaha study area is divided into two generalized soil association areas. These areas are depicted in figure C-1. The associations are described as follows.

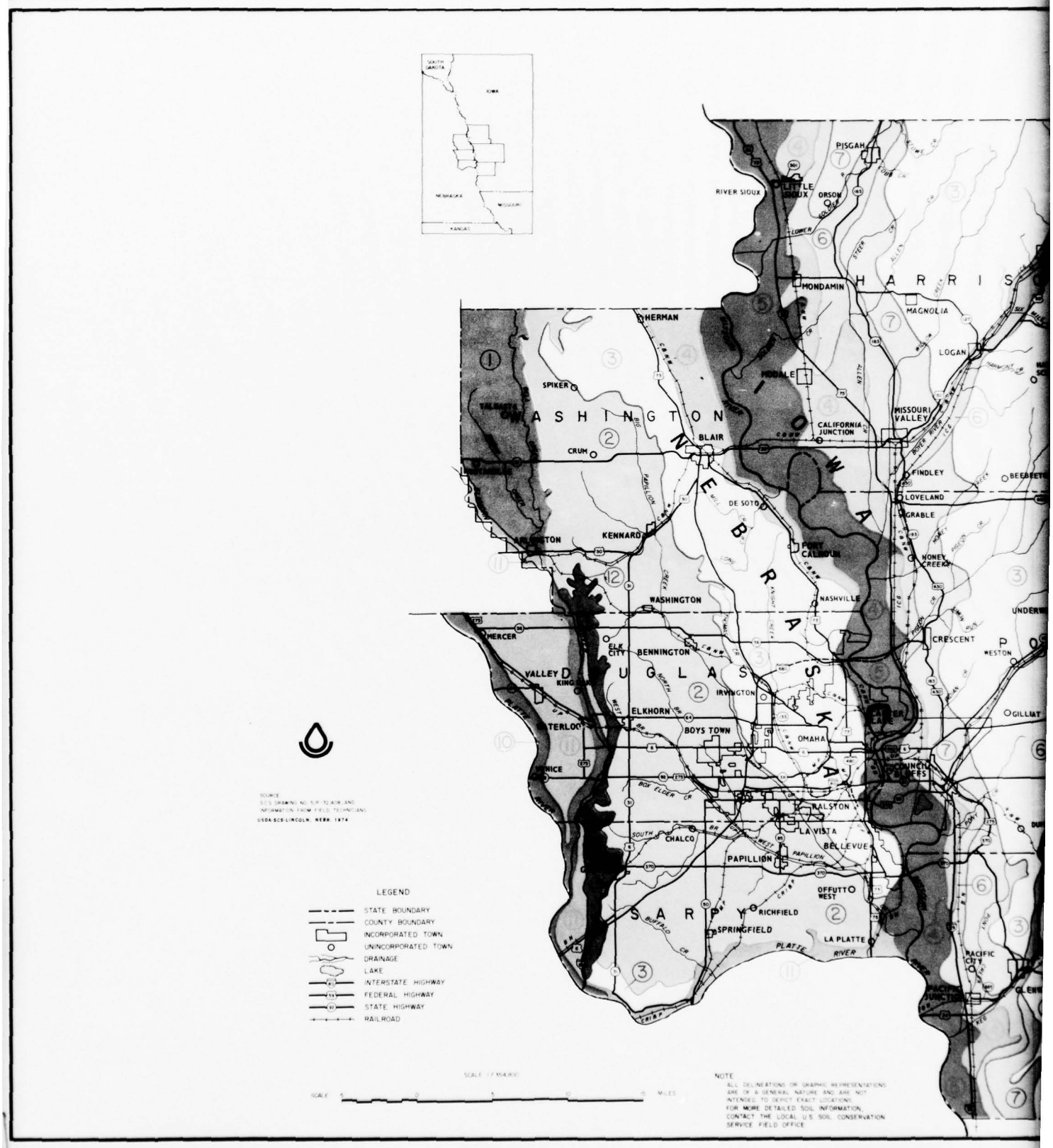
2. Area 1 - Monona Ida-Association. These soils are deep, well-drained, medium-textured soils formed on loess uplands. The permeability is moderate, averaging 0.6-2.0 inches per hour. The ground water depth is greater than 5 feet. These soils are found in the upland areas of the study area.

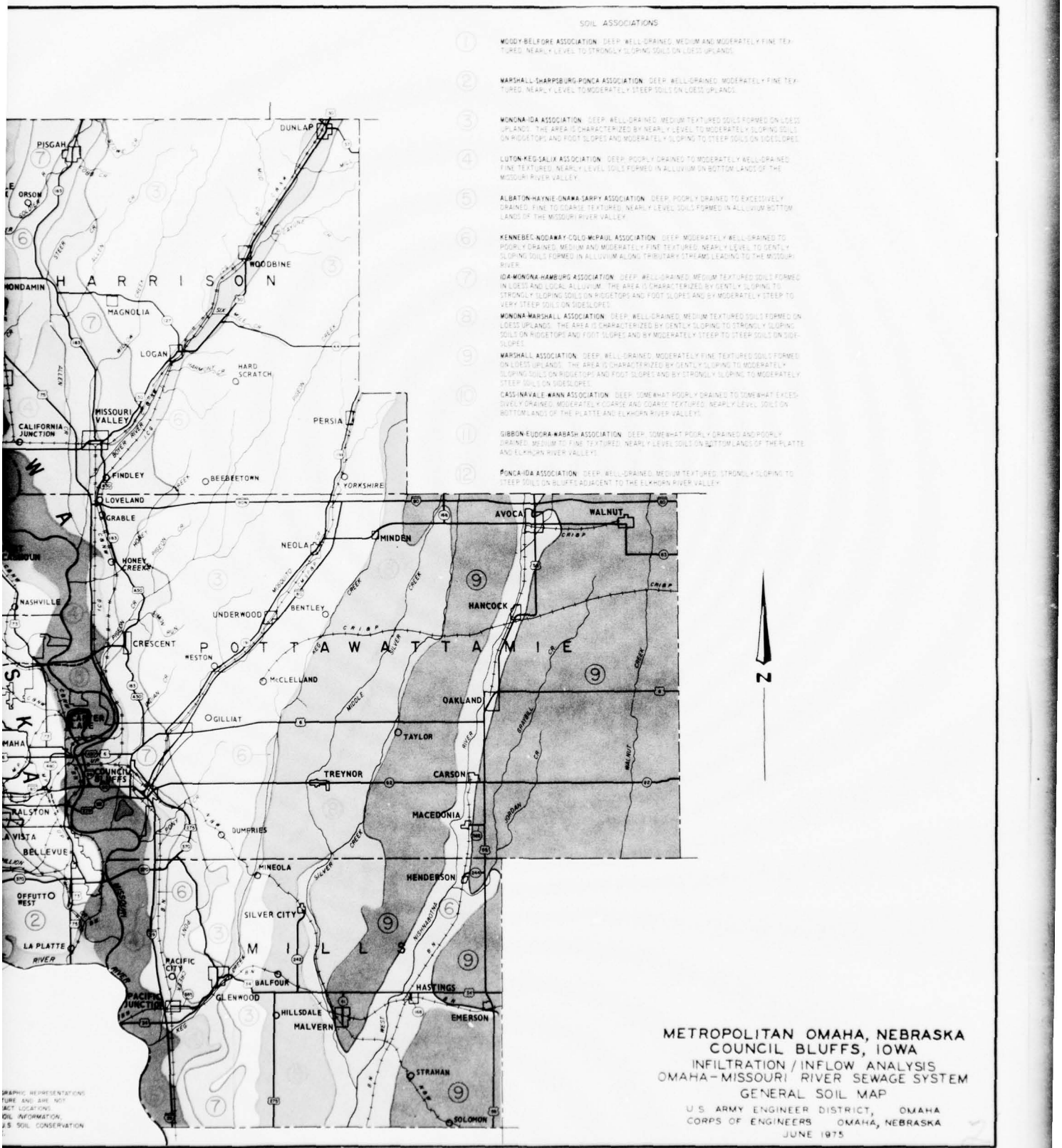
3. Area 2 - Albaton-Haynie-Onawa-Sarpy Association. These soils are deep, poorly drained to excessively drained, fine to coarse textured, and nearly level soils which are formed in alluvial bottom lands of the Missouri River valley. This soil has a slow

permeability of less than 0.06-0.2 inches per hour with a high shrink-swell potential. Ground water is found at depths between 1 to 3 feet. These soils are found in the flood plain of the study area.

4. The study area lies within the Missouri River valley which has eroded into the broad loess-mantled upland till plain. The bluffs above the Missouri River are composed mostly of loess and glacial till; and in some cases, bedrock is exposed along the bluffs. Overburden in the valley consists of alluvium and alluvial terraces. The alluvium ranges in thickness from 60 to 100 feet and is composed of gravel, sand, silt, and areas of clay that are up to 40 feet in thickness.

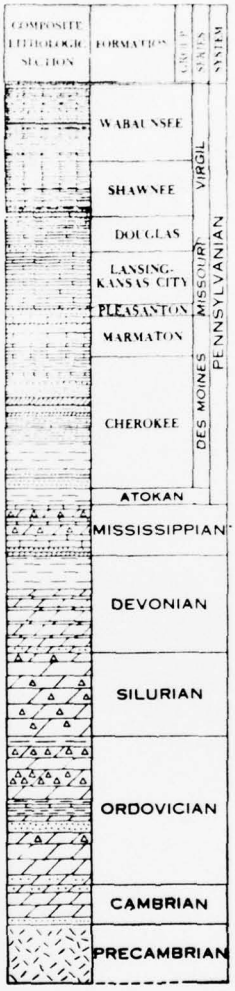
5. Beneath the alluvium, about 2,000 feet of sedimentary rock overlies Pre-cambrian granite in the Omaha area. The rock consists largely of shale, sandstone, limestone, and dolomite ranging in age from Pennsylvanian to Cambrian. The uppermost bedrock unit underlying the Omaha area is the Kansas City Group which consists of relatively pure limestone though much of the Group is thin-bedded. Underlying the Kansas City Group is the Marmaton Group which consists of about 300 feet of thin-bedded shales, siltstone, and sandstone. This Group's base marks the base of the Pennsylvania rocks. Below the Pennsylvanian rocks, about 450 to 700 feet below the surface, is about 200 feet of massive limestone and dolomite of Mississippian age. Figure C-2 shows a generalized columnar section of the Omaha area.


SOUTH DAKOTA
IOWA
NEBRASKA
MISSOURI
KANSAS
PISGAH
LITTLE SIOUX
ORSON
RIVER SIOUX
MONDAMIN
HARRISON
MAGNOLIA
HERMAN
LOGAN
SPIKER
PERSHALE
WASHINGTON
CALIFORNIA JUNCTION
MISSOURI VALLEY
BLAIR
CRUM
FINDLEY
LOVELAND
GRABLE
DE SOTO
KENNARD
FORT CALHOUN
HONEY CREEK
WASHINGTON
NASHVILLE
MERCER
ELK CITY
BENNINGTON
CRESCENT
WESTON
VALLEY
KING
DOUGLAS
IRVINGTON
ELKHORN
BOYS TOWN
OMAHA
GILLIAT
WATERLOO
BOX ELDER CR
RALSTON
LA VISTA
CHALCO
BELLEVUE
PAPILLION
OFFUTT WEST
SARPY
RICHFIELD
SPRINGFIELD
LA PLATTE
PLATTE RIVER
PACIFIC CITY
LEGEND
STATE BOUNDARY
COUNTY BOUNDARY
INCORPORATED TOWN
UNINCORPORATED TOWN
DRAINAGE
LAKE
INTERSTATE HIGHWAY
FEDERAL HIGHWAY
STATE HIGHWAY
RAILROAD
SCALE
NOTE
ALL DELINEATIONS OR GRAPHIC REPRESENTATIONS ARE OF A GENERAL NATURE AND ARE NOT INTENDED TO DEPICT EXACT LOCATIONS. FOR MORE DETAILED SOIL INFORMATION, CONTACT THE LOCAL U.S. SOIL CONSERVATION SERVICE FIELD OFFICE.

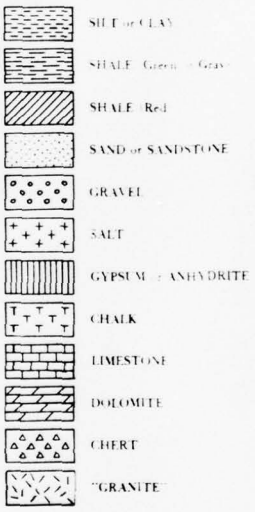


VOLUME V ANNEX E FIGURE C-1

Approximate Top of Bedrock in the Omaha Area



EXPLANATION OF SYMBOLS



Source :
From Bedrock Geologic Map of Nebraska, Nebraska Geological Survey.

METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA

GEOLOGICAL CROSS SECTION

U. S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA

JUNE 1975

VOLUME V ANNEX E FIGURE C-2

TOPOGRAPHY

6. Topography in the study area is greatly influenced by the Missouri River which forms the eastern limit of the Omaha-Missouri River sewerage system. Along the west bank of the river, the land in the study area is low-lying flood plain which is now protected by a levee. In the northern half of the study area for a distance of about 5 miles from the river, the land rises gradually to an elevation of 200 feet above the Missouri. In the southern half, the land rises sharply in steep bluffs 200 to 500 feet from the river. These bluffs are 100 to 150 feet above the river level. Figure C-3 is a map depicting the topography of the study area.

7. The northern half of the study area contains a large flood plain that is nearly flat. This area rises only 40 feet above the Missouri River. Carter Lake which is an oxbow lake lies in the center of this area and receives surface runoff from the surrounding 4,000 acre area. The rest of the northern half contains rolling hills and valleys that slope toward the Missouri River.

8. The southern half of the study area also contains rolling hills and valleys. The main topographic difference between the two halves is the steep bluffs which are closer to the river in the southern half.

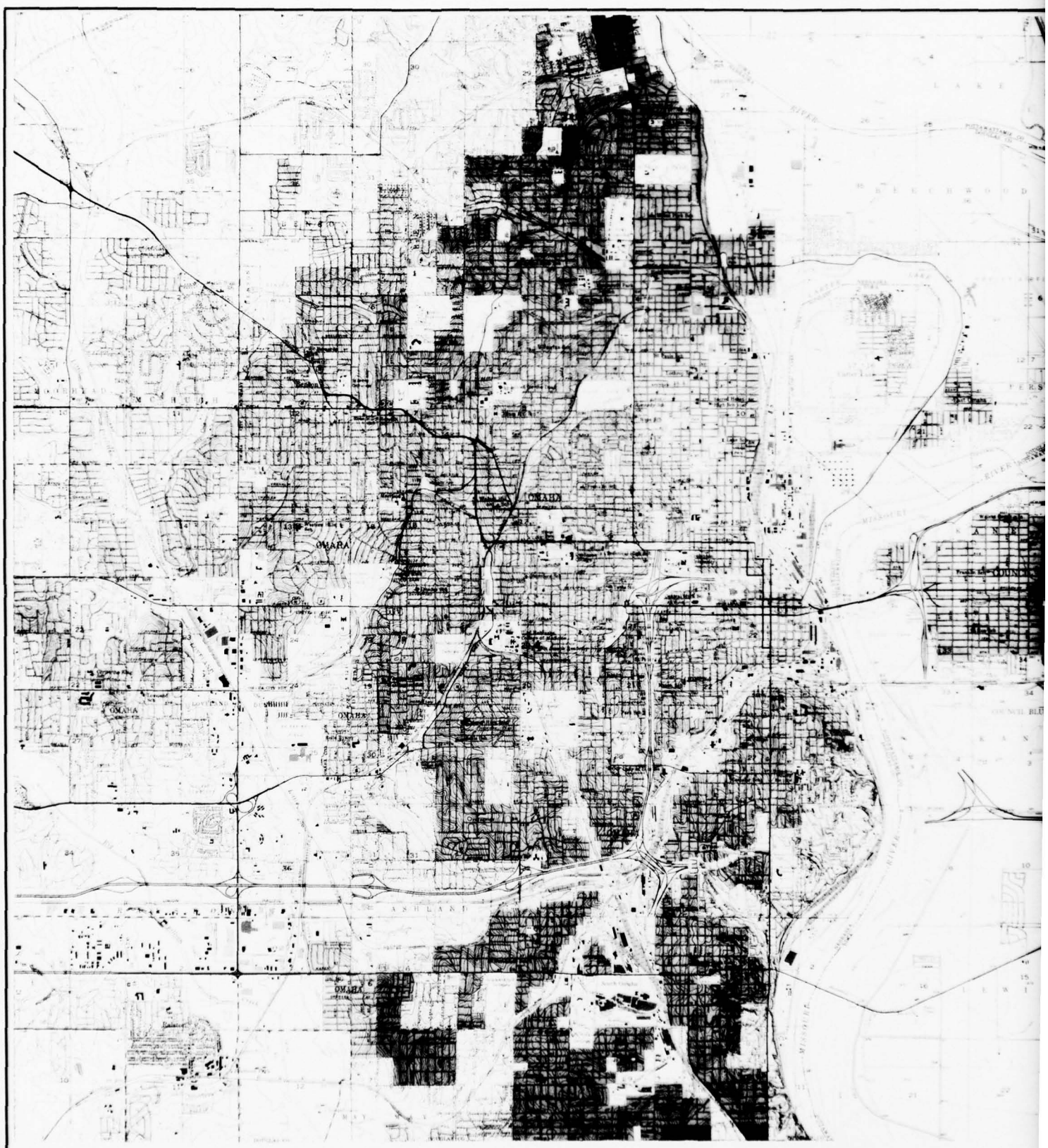
9. Drainage in the study area follows the natural drainage ways. Except for the flat area around Carter Lake, the study area drains directly to the Missouri River. Sewer gradients generally follow the natural slope of the land.

CLIMATE

10. Omaha is located between two distinct climatic zones; the humid east and the sub-humid west. As a result, the summers are warm and the winters are cold and dry. The study area is subject to periodic and rapid changes in weather such as high-intensity thunderstorms that may center over a localized area. An analysis of 24 years of data by the Corps of Engineers gives an average of 30.46 inches of rainfall per year. The average annual snowfall is 31.2 inches. Only 10 percent of the total annual precipitation falls during the winter months while 75 percent of the total falls during the 6-month period from April through September.

POPULATION

11. Recent population growth in Omaha has resulted in westward expansion of the city limits rather than in an increase in population density in the study area. Future growth, however, is expected to occur in the study area as the Riverfront Development Program is carried out and the downtown central business district is redeveloped. This growth is projected to increase the study area's present population from 173,000 to 189,000 by 1995 and to 205,000 by 2020.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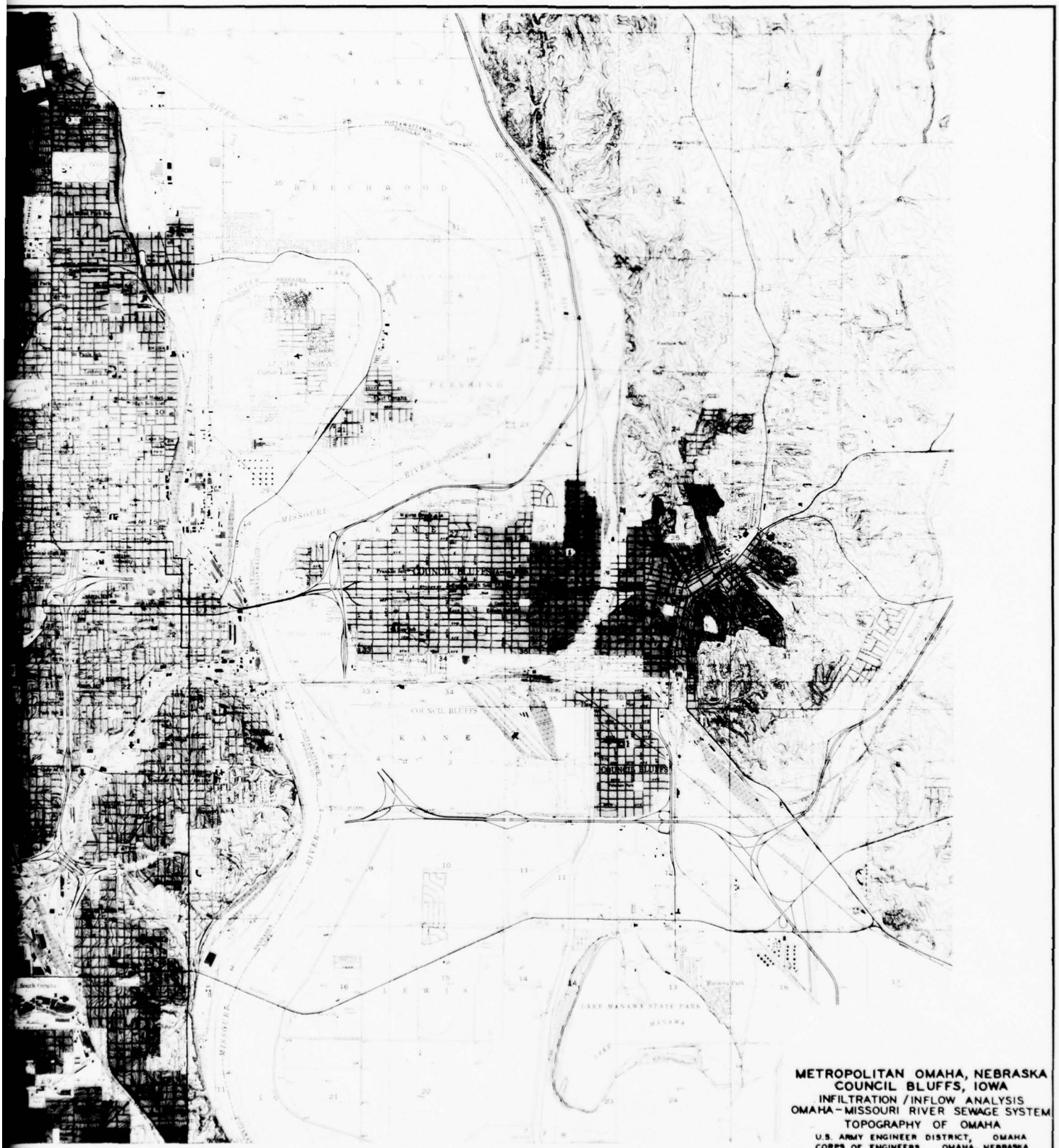


METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA
INFILTRATION / INFLOW ANALYSIS
OMAHA - MISSOURI RIVER SEWAGE SYSTEM
TOPOGRAPHY OF OMAHA
U.S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA
JUNE 1975

System Description

SYSTEM OVERVIEW

12. Sewage in the study area is conveyed by trunk sewers in each service area to an interceptor system which conveys the sewage to a treatment plant which provides primary treatment. The Omaha-Missouri River sewerage system consists of 10 main service areas, eight of which run into the main interceptor system. The Monroe Street and South Omaha service area flows go directly to the Missouri River treatment plant. Wastewater from all of the service areas can either overflow from any one or more of the 20 overflow points along the interceptor system or be diverted to the treatment plant. This system is shown in figure C-4.

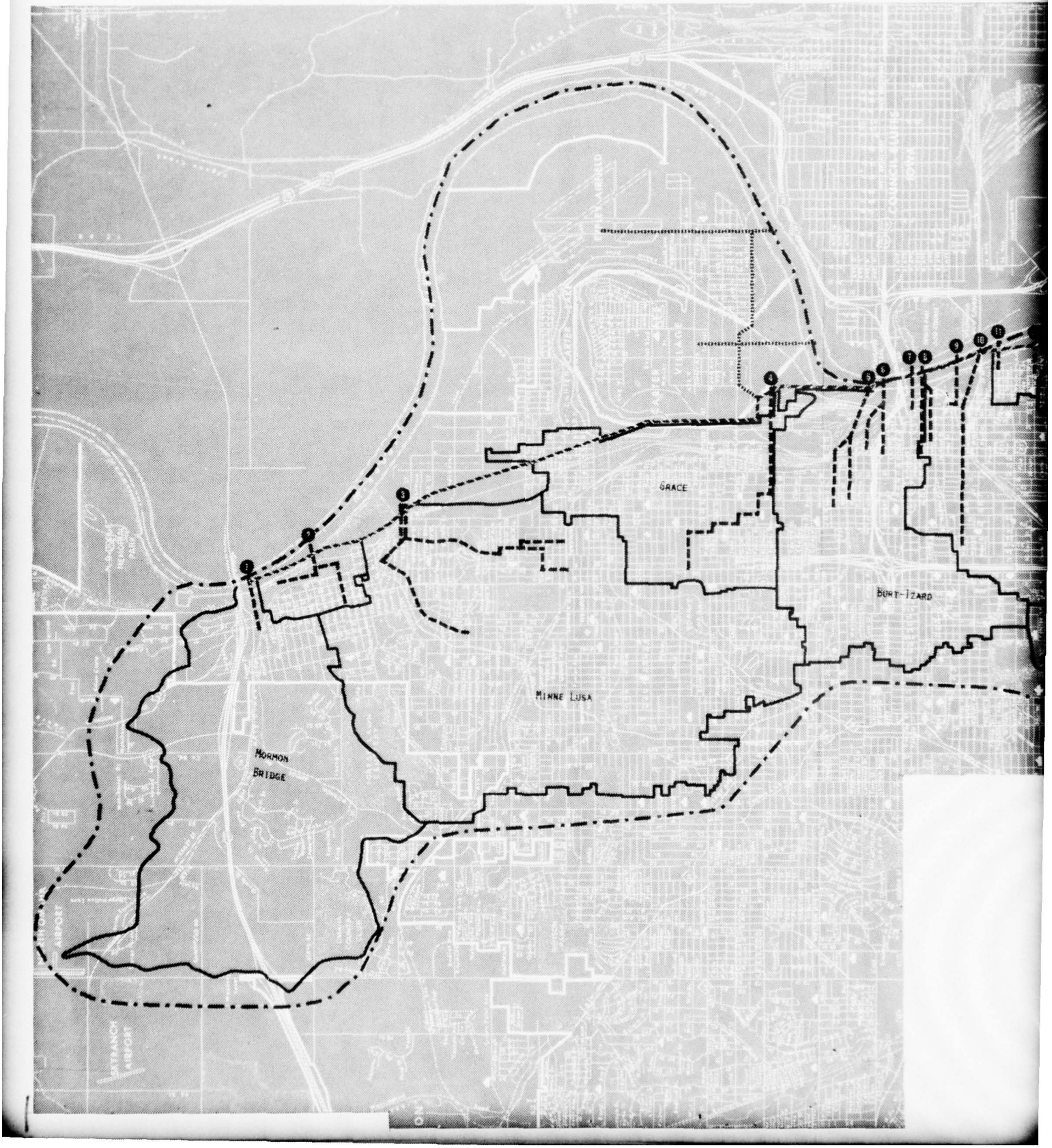
13. The collection system is mainly constructed of clay pipe with bell and spigot joints. As the sewer pipes get larger, the use of brick sewer pipe predominates. In areas of newer construction, concrete pipe is used for the larger pipes. Concrete box culverts are used in areas where the required pipe size is greater than about 13 feet. This system ranges in depth from 5 feet to 60 feet with the average depth from 15 to 20 feet.

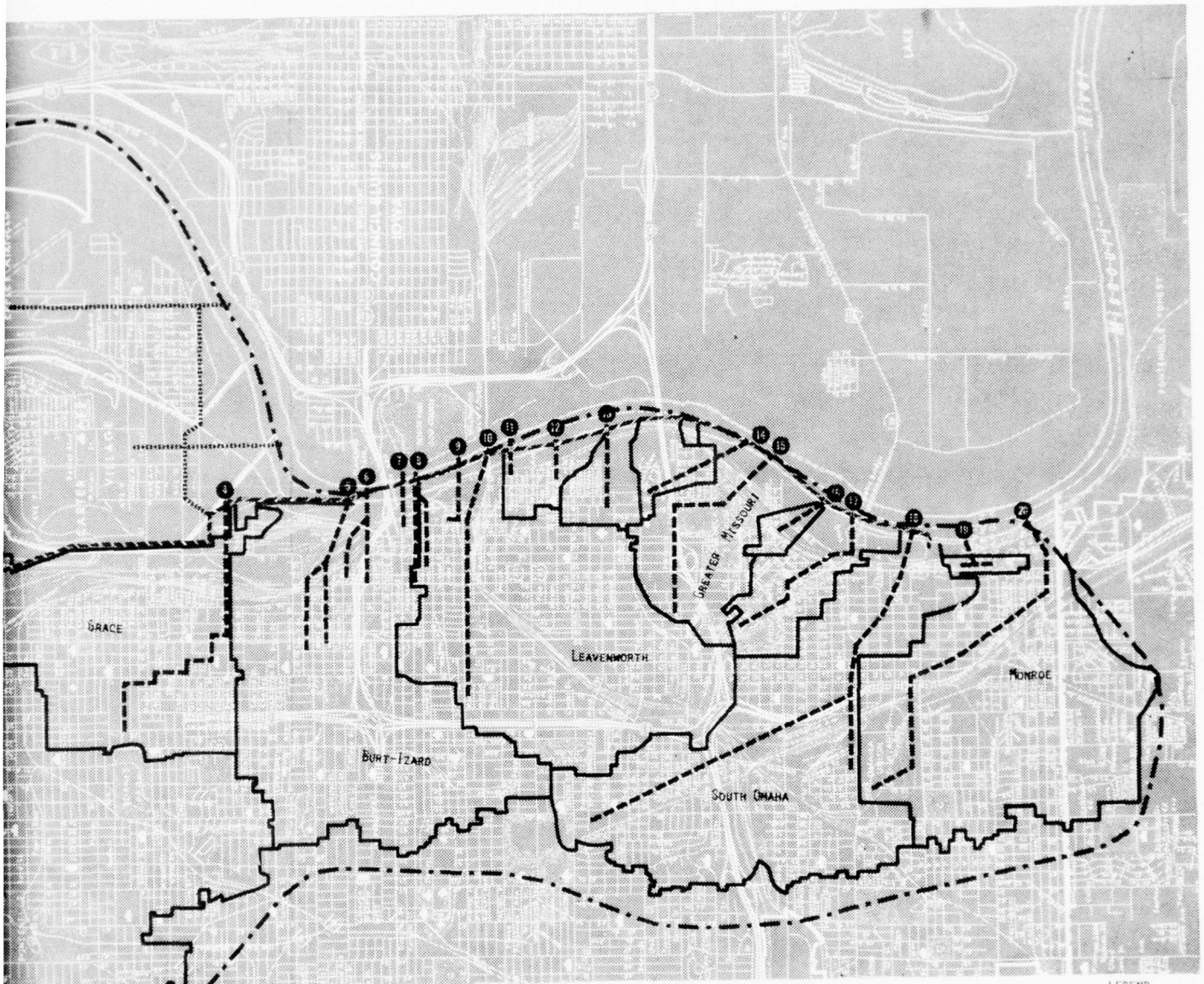
14. The city of Omaha sewer maintenance department feels that the system is in good condition, particularly with respect to infiltration. Minor repairs and regular maintenance are required at this time to keep the system functioning properly. The system is getting older and the maintenance schedule of the system has

been and will continue to increase in order to keep ahead of any major system failures. The repairs presently consist mainly of replacing a few sections of bad pipe at a given location. The system becomes overloaded in certain areas during storms as is shown on figure C-5. The reason for this is that the sewers are not designed to accommodate the high flows they are required to carry during storm events. In general, no major problem areas presently exist within the sewage collection system itself.

15. The construction of the system, a combined system, was initiated near the turn of the century. The first big sewer construction program came into effect between 1904 and 1910. Since then, there have been three periods of expansion when large segments of sewer were added. These periods occurred during 1916 to 1926, 1935 to 1941, and 1946 to 1950. These four periods of construction would mean that major portions of the combined sewer system range in age from 25 to 70 years. In 1950, construction of a sanitary sewer system was initiated in the Carter Lake-East Omaha area and is presently still being expanded. The collection system for the Bridge Street service area was separated within the last 20 years.

16. These sewer systems conveyed the wastewater from the service areas and discharged them directly into the Missouri River until 1964. In 1964, an interceptor system was completed and the flow was then diverted and conveyed to a new primary sewage treatment plant. This interceptor was designed to carry the dry-weather flow and some wet-weather flow. Depending on where the excess wet-weather flow is discharged to the river, the interceptor system carries only three or five times the design dry-weather flow during


GRACE
BURT-IZARD
MINNE LUSA
MORMON
BRIDGE
AIRPORT
AIRPORT



LEGEND

EXISTING

SERVICE AREA BOUNDARY

N OMAHA INTERCEPTOR

S OMAHA INTERCEPTOR

COMBINED TRUNK SEWER

SANITARY TRUNK SEWER

COMBINED SEWER OVERFLOW POINT

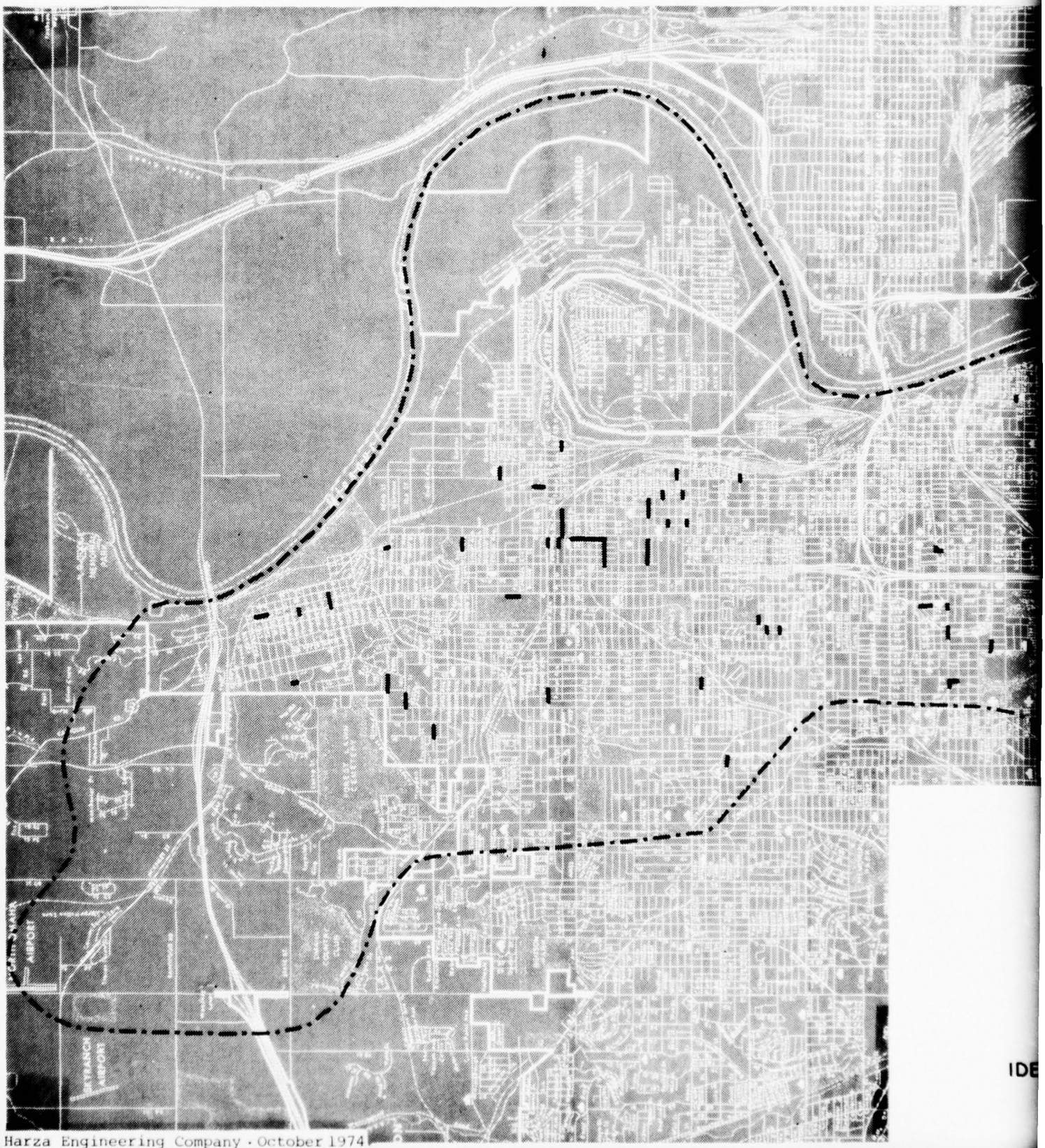
METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA

OMAHA - MISSOURI RIVER SEWERAGE SYSTEM

U. S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA

JUNE 1975

VOLUME V ANNEX E FIGURE C-4



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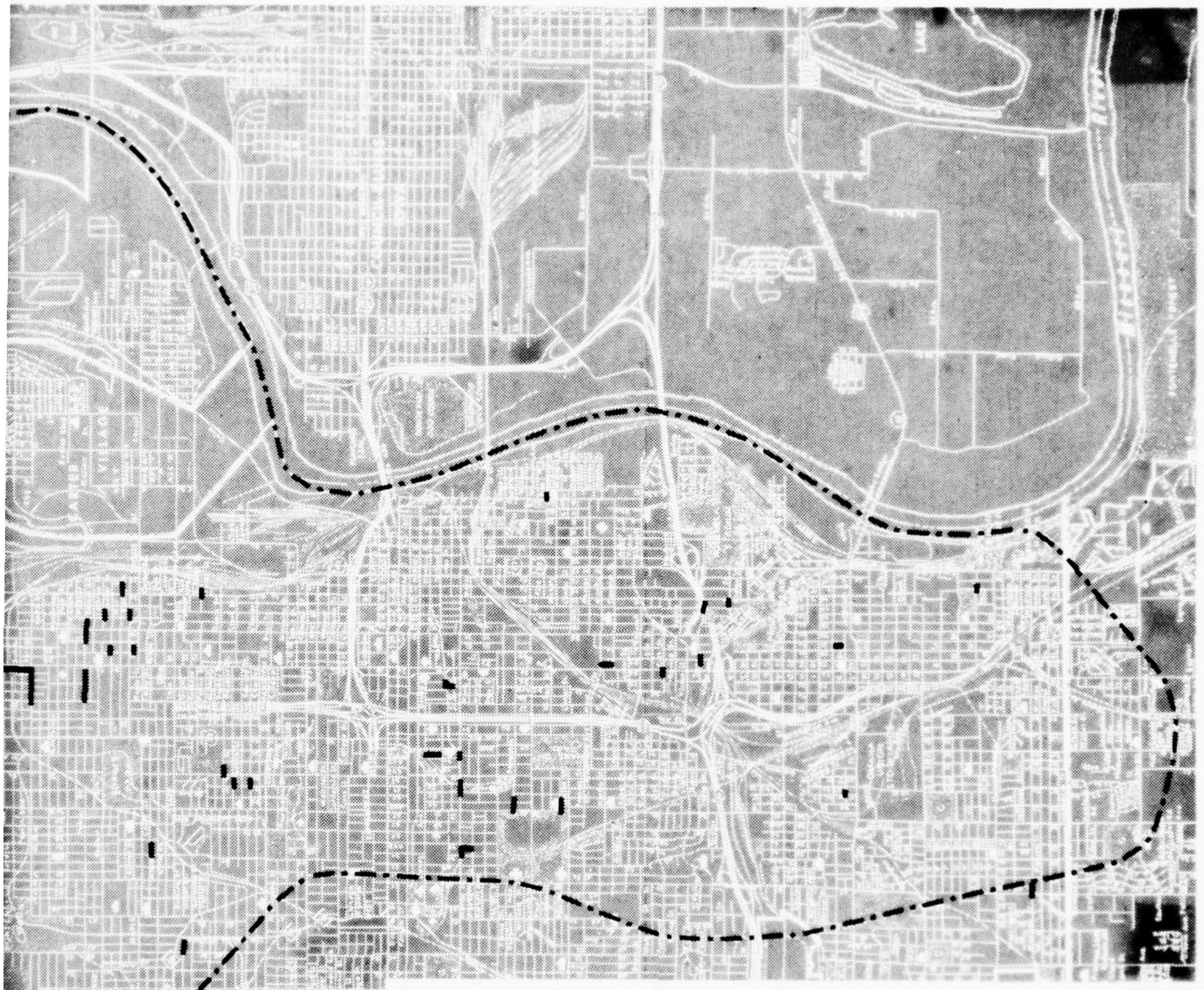
Harza Engineering Company · October 1974



LEGEND

Combined Sewer Service Area

Local Flooding Problems

METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA
INFILTRATION / INFLOW ANALYSIS
OMAHA - MISSOURI RIVER SEWAGE SYSTEM
IDENTIFICATION OF LOCAL FLOODING PROBLEMS

U.S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA
JUNE 1975

VOLUME V ANNEX E FIGURE C-5

times of high wet-weather flow. The excess flows are discharged directly to the Missouri River approximately 50 times a year. Harza Engineering Company prepared a report for the Corps' urban study entitled "Alternative Plans for Abatement of Pollution from Combined Sewer Overflows - Omaha, Nebraska". The report presents several alternatives which indicate that these excess wet-weather discharges to the river should be handled in a system separate from the present interceptor system.

17. The interceptor system consists of the North Omaha Interceptor, the South Omaha Interceptor, grit removal facilities and pump stations, and diversion structures. It conveys wastewater to the treatment plant from all main service areas except two, the South Omaha and Monroe Street areas. The interceptor system was designed to convey all wastewater to the Missouri River plant so long as the proportion of the stormwater flow to the design dry-weather flow does not exceed a prescribed ratio. This ratio varies depending upon the location of the overflow point. For the North Omaha Interceptor which is upstream of the Council Bluffs' raw water intake, the ratio is 5 to 1. For the South Omaha Interceptor, the ratio is 3 to 1. Flows exceeding these ratios bypass the interceptor system and are discharged without treatment to the Missouri River.

NORTH OMAHA INTERCEPTOR

18. The North Omaha Interceptor collects the sanitary sewage from the Bridge Street, Mormon Street, and Minne Lusa service areas. The sewer ranges in size from 30 inches in diameter near Bridge Street to a 10-foot by 7.5 foot box sewer at Grace Street. This

portion of the interceptor system was built during the period from 1960 to 1962. The interceptor is constructed of reinforced concrete which was placed monolithically and is in good condition. All of the wastewater enters and flows through this interceptor by gravity, except the flow from Bridge Street where there is a lift station to get the sanitary flow into the interceptor. Near the Grace Street service area discharge point to the river, the flow in the North Interceptor is diverted to the South Interceptor. All flows in the North Interceptor are diluted to 5:1 during heavy rains.

SOUTH OMAHA INTERCEPTOR

19. The South Omaha Interceptor connects with the North Omaha Interceptor at Grace Street. This interceptor collects flow from the North Omaha Interceptor and the Carter Lake-East Omaha, Grace Street, Burt-Izard, Leavenworth Street, and Greater Missouri Avenue service areas. Between its beginning at Grace Street and the Burt-Izard overflow, the South Omaha Interceptor consists of a 60-inch diameter gravity sewer. From the Burt-Izard lift station to the Leavenworth lift station, the interceptor consists of a 48-inch diameter force main; and from Leavenworth to the treatment plant, a 66-inch diameter force main. This portion of the system was completed in 1964. The interceptor is constructed of reinforced concrete which was placed monolithically. It is presently in good condition. All service area flows that discharge into this interceptor are diluted to 3:1 during heavy rains.

GRIT REMOVAL FACILITIES AND PUMP STATIONS

20. Grit removal facilitiss are located throughout the system. Grit is removed from all wastewater flow prior to the time it reaches the Missouri River treatment plant, except for a small amount of flow that emanates from a small area within the South Omaha service area known as "U" Street. Most of the facilities are located in or before the pump stations. There is also a grit chamber located in the North Interceptor south of the Minne Lusa diversion structure. Grit is also removed from most of the flow from the South Omaha service area.

21. During periods of high runoff, large, heavy objects are carried by the wastewater to the outfall. Some of these objects, such as bricks from the sewer lining and tree branches, are diverted to the grit removal and pumping facilities where they damage equipment. After the storm runoff stops, the facilities can be repaired,but only by discharging the dry-weather sewage directly to the Missouri River. The wastewater has to be bypassed since there is no redundancy in the grit removal and pump station facilities to handle flow during periods of mechanical breakdown.

22. All of the existing grit removal and pumping facilities along the South Omaha Interceptor lack provisions for preventing dry-weather bypassing during periods of repair and mechanical failure. The facilities at Burt-Izard and Leavenworth have caused the greatest problems. The Burt-Izard facility is extremely critical because the flows from the North Omaha Interceptor and the Carter Lake-East Omaha, Grace Street, and Burt-Izard service areas are pumped by this facility. Whenever repairs are necessary to these facilities, flows must be bypassed directly

to the Missouri River. Bypassing because of mechanical failures occurs frequently along the interceptor system. The city of Omaha estimates that the dry-weather bypasses totalled at least 4.5 billion gallons during 1973. Table C-1 indicates that the bypassing is a major problem since flows to the Missouri River treatment plant ranged from 6.5 to 26.7 MGD. Annual average daily flow should be about 24 MGD, according to the analysis presented in this report on wet-weather flows.

DIVERSION STRUCTURES

23. Diversion structures are located near the outfall of each sewer system in order to control the quantity of flow that may be directed into the interceptor. Dry-weather flow is directed into the grit removal facility or lift station at each site. Essentially, the operation of these structures consists of running the combined sewer flow through a coarse bar screen and into the diversion pipe below. Bypassing to the Missouri River occurs when the flow exceeds the capacity of the diversion pipe or when the grit or pump facilities malfunction or are under repair. In other structures, bypassing of storm flow is accomplished by using a diversion dam or double-pipe arrangement. Bypass is accomplished automatically when the wet-weather flow overflows the small dam or pipe into the line leading to the river. The type of diversion structure used to serve a given sewer will be outlined in the description of individual service areas.

Table C-1
Average Monthly Flow Received By Treatment Plant
(Year - 1973)

Month	Influent Flow North (MGD)	Influent Flow South (MGD)	Total Influent Flow (MGD)
January	6.4	11.2	17.6
February	9.1	13.0	22.1
March	14.4	12.3	26.7
April	9.4	9.3	18.7
May	8.2	12.9	21.1
June	12.2	6.6	18.8
July	8.3	4.7	13.0
August	2.5	4.0	6.5
September	3.4	3.4	6.8
October	10.1	3.2	13.3
November	8.6	3.4	12.0

December - Flow Recorder Out of Service.

SERVICE AREAS

24. The Omaha-Missouri River sewerage system consists of 10 sewer service areas. The sewer service areas tend to conform to the natural drainage boundaries. In several of the service areas, the main collection sewers were constructed in natural drainage ways such as creeks or streambeds. Each service area consists of a sewer collection system that conveys sewage and in eight of the areas, stormwater runoff via one or more trunk sewers to the interceptor system. Wastewater from these service areas can be discharged to the Missouri River from any one or more of 22 locations. Of these, 19 are combined sewer overflow points, two are sanitary sewer outlets serving the Carter Lake-East Omaha area, and the remaining point is a separate storm sewer overflow in the Bridge Street area. The two sanitary sewer outlets were used prior to the construction of the interceptor system and are not presently used.

25. The 10 sewer service areas involved in the infiltration/inflow analysis are as follows: Bridge Street, Mormon Street, Minne Lusa, Carter Lake-East Omaha, Grace Street, Burt-Izard, Leavenworth Street, Greater Missouri Avenue, South Omaha, and Monroe Street. A block flow diagram of the sewer system is shown as figure B-2. A detailed description of each service area follows.

BRIDGE STREET

26. The Bridge Street service area serves 3,915 acres near the north edge of the city limits. The area is presently served by a recently separated sewer. The portion of the area served is on the eastern end of the service area and lies within the city limits north of Young Street. The stormwater runoff from this service area drains into Mill Creek, which empties into the Missouri River.

27. The sewer collection system has been separated within the last 10 to 20 years. The last sections were separated during 1974. This system is composed of about 14 miles of vitrified clay pipe which ranges in size from 8 to 48 inches. City officials indicate that it is in good condition. All dry-weather flow goes to the Bridge Street lift station where grit is removed and it is pumped through a force main to the North Interceptor. The North Interceptor is a 30-inch pipe at this point.

28. The 1970 population of the area served by this sewer was 5,320. Using 50 gallons per capita per day as an average consumption figure, the domestic wastewater flow is 0.266 MGD. There is no industrial flow from this area; therefore, there is total water consumption of 0.266 MGD. Weir flow measurements indicate that

only 0.109 MGD flows from this service area. No wet-weather flow enters this system since it has been recently separated.

MORMON STREET

29. The Mormon Street combined sewer serves a drainage area of approximately 316 acres in the northern part of Omaha commonly known as Florence. The area is bordered by the Missouri River on the east, Filmore Street on the north, 31st Street on the west, and Weber Street on the south. This area is mostly residential and serves a population of 2,100.

30. The collection system is clay pipe which was placed in 1917 and 1919. There are about 10 miles of sewer that are considered to be in good condition. This system empties into a 5-foot brick sewer line. The wastewater flow, which is less than five times the design dry-weather flow, is diverted through a bar screen into a diversion pipe. The diverted flow then joins the flow from the Bridge Street service area in the North Interceptor. The North Interceptor becomes a 36-inch pipe at this junction.

31. Domestic consumption is 0.105 MGD based on an average domestic consumption of 50 gpcd. Industrial and commercial consumption is 0.23 MGD. Measured dry-weather flow is 0.199 MGD. Wet-weather runoff is 0.313 MGD, but an average of only 0.051 MGD is diverted to the interceptor.

MINNE LUSA

32. The Minne Lusa combined sewer system is the largest in the study area and serves an area of 5,360 acres in the north central part of Omaha. The boundaries are Reynolds Street on the north,

Decatur Street on the south, 51st Street on the west, and from 20th to 30th Street on the east. The area is primarily residential with a little industry in the eastern reaches of the area.

33. Basically, the wastewater is collected and flows to the north and east. The flow is carried by four main branches which combine into one trunk sewer at the intersection of Minne Lusa Boulevard and Sharon Drive. Prior to this junction, the sewer consists mainly of clay pipe and brick sewer pipe that ranges in size from 8 inches to over 10 feet in diameter. There are also two sections of box culvert that are 9 by 16 feet and 11 feet 3 inches by 17 feet in size. The main trunk sewer that carries the flow toward the river is 12 by 18 feet. The flow from Minne Lusa is combined with the flow from the Bridge Street and Mormon Street service areas in the North Interceptor at the intersection of Sharon Drive and Minne Lusa Boulevard. These flows are prevented from flowing into the river by a diversion dam in the box culvert. When the flow exceeds the 5 to 1 ratio, the excess flows over the dam and goes to the river.

34. The majority of the collection system is from 40 to 70 years old and in good condition, even though it is overloaded in some of the upsystem areas during storms. In 1962, the Minne Lusa relief sewer was constructed in order to take some of the load off of the older system and to help eliminate some bad flooding conditions. A diversion structure prevents flow from entering this sewer except when large stormflows occur. This sewer connects to the old sewer at 27th and Sprague and is a 108-inch concrete pipe. This pipe is connected to the North Interceptor at Cornish Boulevard by a junction box. The interceptor is a 72-inch pipe north of the

junction box and is a 10-foot by 7-foot 6-inch horseshoe box south of the junction box.

35. Since this service area is the largest and is mainly residential, the sewer system serves more people (47,050) than any other system in the study area. Based on 50 gpcd, the domestic consumption of water is estimated to be 2.352 MGD. An industrial flow of 0.580 MGD raises the water consumption to an estimated 2.932 MGD. The average dry-weather flow measured by a permanent recorder at the Minne Lusa diversion structure is 1.5 MGD. Subtraction of the flows from Bridge Street and Mormon Street leaves 1.193 MGD for the dry-weather flow from the Minne Lusa service area. Wet-weather runoff is estimated to be 5.323 MGD, but only 0.861 MGD of this flow is diverted to the interceptor system.

CARTER LAKE - EAST OMAHA

36. The Carter Lake - East Omaha sewer system which was initiated in 1950 serves the area in northern Omaha east of 10th Street. This area is bounded on three sides by the Missouri River and includes Eppley Airfield. This sewer system is replacing the septic tank systems that once served this area and is strictly a sanitary sewer. The population of this area was 5,925 in 1970, but an estimated 3,630 persons are served by the new sewer system.

37. This system consists entirely of vitrified clay pipe which ranges in size from an 8-inch pipe that serves Carter Lake and a 15-inch pipe that serves Eppley Airfield to a 24-inch pipe. Even though this sewer is relatively new, it is considered to be in only fair condition; repairs are constantly needed.

38. The Carter Lake - East Omaha flow enters the South Interceptor near the Grace Street diversion structure.

39. Domestic consumption for the area presently served by sewers is estimated to be 0.181 MGD. The only other flows emanate from the Eppley Airfield area and total 0.057 MGD. Therefore, total water consumption is 0.238 MGD. City of Omaha flow measurements are 0.227 MGD for the Carter Lake sewer and 0.055 MGD for the flow from Eppley Airfield. It is assumed that there are no wet-weather flow increases since the sewer is a separated sewer.

GRACE STREET

40. The Grace Street sewer system serves the north-central and northeast sections of Omaha. The area contains approximately 1,680 acres and extends from Sprague Street on the north to Parker Street on the south and from 13th to 31st Streets. This area is mainly residential with industry in the lower areas along the east side of the service area. Census data for 1970 lists a population of 20,635 for this service area.

41. This area is served by a combined sewer that was constructed in the 1920's. The collection system is mainly clay pipe with the larger trunk sewers being reinforced concrete. The sewer ranged in size from 8-inch pipe to a two-barrel 7-foot 3-inch by 9-foot box culvert. The system is approximately 62 miles long and is considered to be in good condition by the city of Omaha sewer maintenance department.

42. Flow from this service area that is less than 3 times the design dry-weather flow is diverted prior to its discharge to the

river. This flow joins the flow from the North Interceptor just south of this diversion structure. The South Interceptor is a 60-inch reinforced concrete pipe at this location. The diversion structure consists of a bar screen and recessed floor in each barrel. The wastewater flows to the side of the box and then through a diversion pipe to the interceptor. Flow out of the box is also impeded by a set of flap gates on the outlet of the box.

43. Since this service area is mainly residential, most of the flow is domestic. The domestic water consumption is 1.032 MGD and the industrial flow is 0.234 MGD for a total estimated average dry-weather flow of 1.266 MGD. The measured dry-weather flow was impossible to obtain for the Grace Street service area alone. The city of Omaha cannot get any weirs into the system to adequately obtain a total flow for this service area since the flows are so large. The estimated flow for this area is analysed with the measurements at the Burt-Izard lift station since the Grace Street flow is included in the flow measurement at the lift station. Wet-weather runoff is 1.668 MGD with only 0.270 MGD of this flow entering the interceptor.

BURT-IZARD

44. The Burt-Izard combined sewer system serves an area of approximately 2,270 acres in the east-central part of Omaha. The contributing drainage area is bounded by Parker Street on the north, Woolworth Avenue on the south, 40th Street on the west, and the Missouri River on the east. The system serves residential areas principally, but there are some industrial and commercial developments with large railroad yards and shops in the extreme eastern section. There is little room in this area for new development

which would consequently place heavier loads on the sewer system. The 1970 census indicates a population of 23,610.

45. The system of sewers drain the entire area by gravity to the river during times of low river stage and can best be described as a complex network of brick, concrete, and vitrified clay pipes. Branch sewers from the Bemis Park area, Gifford Park area, and the Dewey Park area converge into one sewer at Burt Street, flow east and then divide into three separate sewers in Nicholas, Izard, and Burt Streets. Another line joins the Izard Street sewer at 17th Street. The various trunk sewers then combine into one trunk sewer east of the Union Pacific shops near the river.

46. The city of Omaha records indicate that this sewer system was constructed mainly in the 1920's and 1930's and is in good condition. This system is about 90 miles long with one-third of it 8-inch pipe and the majority of the rest smaller than 42-inch pipe.

47. All flows less than three times the dry-weather flow are diverted to the Burt-Izard lift station by a depressed floor drain covered by a grate in the trunk sewer. There are also flap gates on the end of this sewer to further impede flow out of the box culvert to the river. The wastewater flow joins wastewater from all service areas that drain into the interceptor system north of the lift station (flows from the service areas previously described). The flow is then pumped up into the South Interceptor which becomes a 48-inch force main at this point.

48. The flow from the Burt-Izard area is part domestic and part industrial. Domestic and industrial flows are estimated to be

1.180 and 0.874 MGD respectively for a total dry-weather flow of 2.054 MGD. The flow from Grace Street is estimated to be 1.266 MGD for a total of 3.320 MGD for the two service areas. This compares to 1.987 MGD as measured by the city of Omaha. Wet-weather runoff is estimated to be 2.254 MGD for the Burt-Izard service area, but only 0.365 MGD is diverted to the interceptor.

LEAVENWORTH STREET

49. The Leavenworth Street service area is located in the southeast quarter of Omaha and covers 2,060 acres of downtown business and residential land. Approximate boundaries of the drainage area are as follows: On the north, Dodge Street; on the west, 24th to 33rd Street; on the south, Grover and "B" Street to 9th and Castelar; on the east, 8th north to Pierce, thence to the Missouri River. This service area can be further broken down into five smaller areas of sewer service. They are Douglas Street, Farnam Street, Harney Street, Jones Street, and Leavenworth Street. The 1970 census indicates that 21,940 persons live in these areas. It is also estimated that approximately 20,000 people work in the downtown business area each day.

50. This sewer system is the oldest in Omaha with construction beginning as early as 1873. Most of the Leavenworth Street sewer system is about 75 years old. Due to its age, the sewer system is only in fair condition according to city officials. The system is basically clay pipe with the larger pipes being constructed of sewer brick or reinforced concrete. The city of Omaha lists a total of 73 miles of sewer for the Leavenworth Street system.

51. The Douglas Street sewer consists of only 0.80 miles of 8-inch to 36-inch pipe. The wastewater flows toward the river where

up to three times the design dry-weather flow is diverted through a 24-inch vitrified clay pipe to the Farnam Street lift station. There the grit is removed and the wastewater is pumped into the 48-inch interceptor. Diversion is accomplished by a recessed floor and grating structure.

52. About 2 miles of sewer are in the Farnam Street system. This system has a maximum pipe size of 42 inches with most of the pipe between 12 and 21 inches. A depressed floor with a cover grate diverts the wastewater flow to the Farnam Street grit chamber and lift station.

53. The Jones Street sewer serves an area of 700 acres in downtown Omaha. About 15 miles of sewer drain into a "U"-shaped section 16 feet wide and 8 feet 4 inches deep. A combination diversion dam-depressed floor structure diverts this flow to the Jones Street lift station where grit is removed and wastewater is pumped into the South Interceptor.

54. The Leavenworth Street sewer receives wastewater from approximately 1,360 acres of primarily residential development. A large valley runs down the center of this area where railroad lines serve some important industries and potential industrial sites. Approximately 55 miles of sewers serve this area ranging in size up to a twin 8-foot 4-inch by 10-foot reinforced concrete box culvert. Most of the pipe is smaller than 60 inches in diameter with the majority 24 inches and smaller.

55. Wastewater flows, up to three times the design dry-weather flow, are diverted to the Leavenworth Street lift station for grit removal and pumping. The diversion structure consists of a depressed

floor and grating draining to a diversion pipe. The South Interceptor becomes a 66-inch force main from this point to the treatment plant.

56. Total dry-weather flow for the entire Leavenworth Street service area is 3.172 MGD with 1.497 MGD being domestic flow and 1.675 MGD being industrial. The 1.497 MGD includes flow from 20,000 office workers at 20 gallons per capita per day. Measured dry-weather flow is 3,890 MGD. An average of only 0.331 MGD of surface runoff enters the interceptor and flows to the Missouri River Treatment Plant even though 2.046 MGD of surface runoff does enter the sewer collection system.

GREATER MISSOURI AVENUE

57. The Greater Missouri Avenue service area includes nine small sewer systems which are the Quaker Oats Company, Pierce Street, Hickory Street, Martha Street, Spring Street, Grover Street, Riverview Park, Homer Street, and Missouri Avenue systems. This service area lies along the Missouri River from Pierce Street south to Missouri Avenue. The western boundary is 8th Street down to Bancroft Street and goes out to 23rd Street before going back to 14th Street at Missouri Avenue. This area is primarily residential with some very large parks in it. Interstate 80 also occupies a large section of it. A total of 2,060 acres and 21,940 people are served.

58. In general, this system is in only fair condition because of its age. City officials say that this system includes some of the oldest sewer in Omaha. This would indicate that it is at least 75 years old in some areas.

59. The Quaker Oats Company discharges a pretreated process waste from the production of furfural. Furfural is a by-product of the cereal industry that is manufactured from oat hulls and corn cobs. This flow is diverted near the river from a 10-inch stainless steel pipe by a valved structure through a 12-inch vitrified clay pipe. This waste flows to the Pierce Street lift station where it is pumped into the interceptor. The average measured flow is 1.258 MGD.

60. The Pierce Street sewer serves a small residential area. Flow from this area is diverted near the river by a depressed floor and grating arrangement to the Pierce Street lift station. Over 3 miles of sewer pipe up to 42 inches in diameter makes up this system. Average measured dry-weather flow from this sewer is 0.606 MGD.

61. Hickory Street is the next sewer system to the south of the Pierce Street system. Less than 2 miles of pipe, ranging in size from 8 inches to 39 inches, serve this residential area. The city of Omaha monitored an average flow of 0.613 MGD from this sewer. This flow is diverted near the river by a depressed floor and grating arrangement to the Hickory Street lift station. This lift station pumps the flow to the South Interceptor.

62. The Martha Street sewer serves a residential area. Five miles of pipe carry the flow to a diversion structure which diverts the flow to the Hickory Street lift station. This diversion structure is another depressed floor and grating structure. An average flow of 0.423 MGD was monitored for this sewer system.

63. The Spring Street sewer is a very small sewer which recently was extended to serve a small residential area. In the past, it served the Burlington Northern shops but the flow from the shops has essentially stopped. Only 1,500 feet of 8-inch pipe serves this area and carries 0.004 MGD of measured flow through the old lift station to a new lift station, which pumps the wastewater to the interceptor. The old lift station serves to pump excessive combined flows to the river.

64. The Grover Street system is another small residential area. This area is served by more than 2 miles of pipe up to 48 inches in size. Measured flow from this area is only 0.059 MGD. This flow is diverted by a depressed floor structure to the Riverview Park lift station.

65. The Riverview Park sewer is a relatively large system which drains a residential and park area. Over 13 miles of pipe, ranging in size from 8 inches to a 6- by 8-foot box, carry the wastewater to a diversion structure which diverts up to three times the design dry-weather flow to the Riverview Park lift station. A measured flow of 0.619 MGD is diverted during periods of dry-weather flow.

66. The Homer Street sewer serves a small residential area. This system consists of almost 3 miles of pipe up to 36 inches in diameter. The city of Omaha measured only 0.089 MGD of dry-weather flow from this area.

67. The Missouri Avenue area is another residential and park area. This area is served by almost 11 miles of sewer which drains into

a 5- by 5-foot box. The flow is diverted by a depressed floor structure to the Riverview Park lift station. This measured flow averages 0.707 MGD.

68. In summary, a total of 11,325 people are served by the eight residential sewers. Using an average of 75 gpcd, it is estimated that 0.849 MGD of domestic wastewater is generated each day. The total industrial flow is 1.453 MGD. Therefore, the estimated dry-weather flow is 2.302 MGD. The city of Omaha has measured a total dry-weather flow of 4.378 MGD. Wet-weather runoff is estimated to be 1.609 MGD with 0.260 MGD entering the interceptor.

SOUTH OMAHA

69. The South Omaha service area is located in south Omaha north of "L" Street. This area is primarily residential but also contains large areas for railroad yards and freeways. The western boundary is 42nd Street. The eastern boundary begins at the Missouri River south of "L" Street and runs northwesterly to 33rd Street at Hickory Street. There are 2,115 acres in this service area.

70. The South Omaha sewer system is quite large, consisting of about 54 miles of pipe. Seventeen miles of 8-inch pipe drain into a system that varies in size up to a 13-foot reinforced concrete pipe. City records indicate that construction of this sewer was started about 45 years ago and that the system is presently in good condition. As in the other service areas, the material of construction is primarily clay pipe, with the larger pipes being reinforced concrete. In this service area, the larger pipes were constructed monolithically.

71. In this service area, the wastewater flows toward the river and is diverted by dropping through a grate in the bottom of the 13-foot pipe to a grit chamber from which it flows by gravity to an in-plant lift station. Flows exceeding a 3 to 1 ratio of wet-weather to design dry-weather flow are bypassed directly to the river.

72. The "U" Street area is a subarea within the South Omaha service area that is served by its own sewer. Wastewater from this residential area flows through about 1.3 miles of sewer pipe to a diversion structure. Flows less than 3 to 1 ratio are diverted to the in-plant lift station. Measured dry-weather flow from this area was only 0.042 MGD.

73. Based on an average consumption of 75 gpcd, the average domestic water consumption for South Omaha was estimated to be 1.320 MGD. Industrial and commercial flows are estimated to be 0.215 MGD. Summing these up, an average water consumption for the South Omaha service area is 1.535 MGD. Estimated wet-weather runoff is 2.100 MGD. Due to bypassing, only an average of 0.340 MGD is diverted to the Missouri River treatment plant.

74. The city of Omaha attempted to obtain an accurate flow measurement for this service area by measuring the depth of flow in the sewer. Using pipe characteristics and this depth measurement, the average daily flow was estimated. This measured flow appears to be too high, especially when compared to the total flow into the south inlet of the Missouri River treatment plant which is measured by a permanent recorder. The city measured 5.24 MGD from South Omaha and the total flow to the south inlet was 9.392 MGD. This

leaves only 4.152 MGD for the Monroe Street service area, and this is too low. Consequently, estimated wastewater flow from South Omaha is included with the Monroe Street figures for comparison purposes.

MONROE STREET

75. The Monroe Street service area serves most of the city of Omaha south of "L" Street and east of 37th Street. Service extends south of the city limits to Chandler Road. This area serves the meatpacking industries as well as a large residential area. Approximately half of the 1,760 acres served are industrial. A total of 17,945 persons live in the area according to 1970 census data.

76. Construction of the sewers began about 1930 so portions of this system have been in operation for over 40 years. City maintenance workers feel that this system is still in good condition. About 45 miles of sewers serve this area with the main trunk sewer being an 11-foot concrete pipe. The dry-weather flow from this pipe enters an 8-foot pipe. During periods of high flow, a second, higher 8-foot pipe south of the first pipe also carries flow which discharges directly to the river. Dry-weather flow and wet-weather flow up to 3 to 1 ratio are diverted from the 8-foot pipe into twin 42-inch pipes. This flow passes through a grit chamber and is then pumped directly to the Missouri River treatment plant.

77. The wet-weather flow from this service area is treated somewhat differently than it is in the other service areas. Flow is diverted through service gates in the side of the north 8-foot pipe into the twin 42-inch pipes. A gate on the end of the 8-foot pipe prevents the flow from going to the river. When the flow gets

so large that the twin 42-inch pipes cannot handle it, the service gates close and the gate on the end of the 8-foot pipe opens. This means that all wet-weather flow goes to the river when the 3 to 1 ratio is exceeded.

78. The major portion of the industrial flow from this area is from the meatpacking plants. This flow is treated in a pretreatment facility before it is discharged to the Monroe Street sewer system. The pretreatment consists of the removal of paunch and grease so that the sewer system does not plug up and fail, especially the 42-inch lines going to the treatment plant. This flow is monitored by a permanent recorder at the pretreatment plant. In August 1974, the 7-day average flow was 4.946 MGD.

79. Domestic flow is estimated to be 1.346 MGD and total industrial flow is 5.128 MGD for a total dry-weather flow of 6.474 MGD. The estimated dry-weather flow from South Omaha is 1.535. Total estimated dry-weather flow to the south inlet of the treatment plant is 8.009 MGD. Recorded dry-weather flow is 9.392 MGD. Estimated wet-weather runoff from Monroe Street is 1.748 MGD, with 0.283 MGD being diverted to the Missouri River treatment plant.

ANALYSIS

80. The wastewater flow analysis data for the study area is shown in tables C-2 and C-3. Table C-2 summarizes the dry-weather flows and table C-3 summarizes the wet-weather flows for the Missouri River treatment plant sewer system.

Table C-2
Dry-Weather Flows

Service Area	Population Served	Per Capita Consumption (gpcd)	Domestic Flow (MGD)	Industrial Flow (MGD)	Water Consumption (MGD)	Measured Dry-Weather Flow (MGD)	Dry-Weather Infiltration[3] (MGD)
Bridge St.	5,320	50	.266	0	.266	.109	- .157
Mormon St.	2,100	"	.105	.023	.128	.199	- .071
Minne Lusa	47,030	"	2.352	.580	2.932	1.193	- 1.739
Carter Lake-East Omaha	3,630[1]	"	.181	.057	.238	.281	.043
Grace St.	20,635	"	1.032	.234	1.266)		
					)	1.978	- 1.342
Burt-Izard	23,610	"	1.180	.874	2.054)		
Leavenworth	21,940	"	1.497[2]	1.675	3.172	3.890	.718
Greater Missouri Ave.	11,325	75	.849	1.453	2.302	4.378	2.076
South Omaha	17,600	"	1.320	.215	1.535)		
					)	9.392	1.383
Monroe St.	17,945	"	1.346	5.128	6.474)		
TOTALS	171,135	ave.= 59.2	10.128	10.239	20.367	21.420	1.053

1/ Total population of area = 5,925 but some of this service area is not served by sewers
2/ Includes 20,000 workers @ 20 gpcd
3/ Minus sign (-) means exfiltration

Table C-3
Wet-Weather Flows

Service Area	Area (acres)	Runoff[2] to M.R.T.P. (MGD)	Total[3] Runoff (MGD)	Wet-Weather[4] Infiltration/Inflow (MGD)		Total Wet-Weather[5] Flow (MGD)	
Bridge St.		[1]	[1]	- .157	- .157	.109	.109
Mormon St.	315	.051	.313	.122	.384	.250	.512
Minne Lusa	5,360	.861	5.323	.878	3.584	2.054	6.516
Carter Lake-East Omaha		[1]	[1]	.043	.043	.281	.281
Grace St.	1,680	.270	1.668	- .707	2.580	2.613	5.900
Burt-Izard	2,270	.365	2.254				
Leavenworth	2,060	.331	2.046	1.049	2.764	4.221	5.936
Greater Missouri Ave.	1,620	.260	1.609	2.336	3.685	4.638	5.987
South Omaha	2,115	.340	2.100	2.006	5.231	10.015	13.240
Monroe St.	1,760	.283	1.748				
Totals	17,180	2.761	17.061	3.814	18.114	24.181	38.481

1/ This service area is not served by combined sewers; therefore, runoff to the sewer system being analysed is assumed to be zero for simplification purposes.

2/ 2.16 (in/yr) x area (acres) x 7.439×10^{-5} where 7.439×10^{-3} is conversion factor from acre-inches/year to MGD.

3/ 13.35 (in/yr) x area (acres) x 7.439×10^{-5} (see 2/).

4/ Equal to runoff to M.R.T.P. or total runoff + dry-weather infiltration (from Table C-2).

5/ Equal to runoff to M.R.T.P. or total runoff + dry-weather flow (from Table C-2).

DRY-WEATHER FLOWS

81. The dry-weather infiltration was determined for each service area by estimating the domestic and industrial (includes commercial) water consumption. The actual dry-weather flows were then measured and the difference between the measured flow and the water consumption figure is the amount of dry-weather infiltration that is suspected of occurring.

82. Domestic water consumption was estimated based on the "Long Range Comprehensive Water System Master Plan" prepared for the Metropolitan Utilities District (MUD) of Omaha by Henningson, Durham, and Richardson indicated that water consumption in the southernmost service areas was about 1.5 times the flow in the northern service areas. The figures of 50 and 75 gallons per capita per day were used in this infiltration/inflow analysis. The weighted average, based on population, is found by dividing the total domestic consumption, 10.128 MGD, by the population served, 171,135. This weighted average is 59 gpcd which agrees with the figure used by Kirkham-Michael and Associates in their report.

83. The average water consumption was verified by a random check of MUD records. Individual customers were selected from all sections of the study area and 1973-74 water consumption records were obtained. Using "Block Statistics" which is a publication by the Bureau of the Census, the average number of people per household were obtained for each location. Based on the customer (household) consumption and the number of people per household, per capita consumption figures were obtained. Based on 49 randomly selected customers, an average consumption of 60 gpcd was obtained.

This figure further substantiates the 59 gpcd average consumption figure that was used in the infiltration/inflow analysis.

84. The water consumption by industries and commercial establishments was obtained from MUD records in all but two cases. Flow for the meatpacking industries was determined from flow records at the Omaha Pollution Control Corporation (OPCC) plant which pretreats the meatpacking wastes for the packing plants prior to discharge into the Monroe Street sewer system. Flow for the Quaker Oats plant in the Greater Missouri Avenue service area was obtained from flow records of their waste at their pretreatment facility.

85. Total dry-weather flow information was obtained by using permanent recorders and weir flow meters with readings taken every hour for 7 days. These recorders and meters were used to measure the total flow through pumping stations, diversion pipes, and key manholes. The locations of the flow measurements are shown in the flow diagram, figure B-2. The flow data gathered at the key manholes was converted from inches of flow over weirs into flow rates in terms of gallons per day. The Omaha Public Works Department furnished the necessary data from each of the ten service areas. These measurements and other dry-weather flow information are summarized in table C-2.

WET-WEATHER FLOWS

86. Wet-weather infiltration/inflow was determined by adding the amount of runoff that enters the system to the dry-weather infiltration. The Bridge Street and Carter Lake - East Omaha service areas were not included in the wet-weather flow computations

since they are served by separate sanitary sewers and significant volumes of runoff should not enter these systems.

87. It is impossible to measure the wet-weather flows since the sewers are combined sewers and the volume of flow is so large. The wet-weather flows were determined using data supplied by the Hydrologic Engineering Branch of the Engineering Division of the Corps of Engineers. Based on 24 years of rainfall data, the average yearly rainfall was found to be 30.46 inches. The Hydrologic Engineering Branch applied this rainfall to the HEC Computer Program, Urban Storm Runoff "Storm", dated May 1974, using runoff coefficients ranging from 0.42 to 0.80, in order to determine the amount of runoff that will occur. It was found that 13.35 inches of annual rainfall became surface runoff and entered the sewer system. A treatment rate of 0.01 inches-per-hour was used to determine the amount of wastewater that was diverted to the interceptor system and flowed to the Missouri River treatment plant. This treatment rate is the capacity of the interceptor and treatment systems. A treatment rate of 0.01 inches per hour means that a flow of 138 MGD flows through the interceptor. An increase to 0.02 inches per hour exceeded the capacity of the system. The treatment rate of 0.01 inches per hour indicated that on an annual basis 2.16 inches of rainfall are diverted to the interceptor system and flow to the Missouri River treatment plant for treatment. By multiplying 2.16 inches per year by the areas of the service areas, the total volume of runoff to the sewer system and Missouri River treatment plant was determined. The remaining runoff of 11.19 inches overflows to the Missouri River. Using the results of these computations, average daily runoff flows were calculated and wet-weather infiltration/inflow was determined

for the sewer collection system and for the Missouri River treatment plant. The results of these computations are shown in table C-3.

88. The city of Omaha estimates that 5 billion gallons of combined sewer flow is discharged to the Missouri River each year. The difference between the total runoff, 17.061 MGD, and the runoff to the Missouri River treatment plant, 2.761 MGD, is 14.300 MGD. This figure times 365, the number of days per year, equals 5.22 billion gallons per year which is close to the estimated figure.

INFILTRATION BACKGROUND

89. Before flows were estimated or measured, the general consensus of the people involved in this analysis was that excessive infiltration/inflow did not exist. The reason for this is twofold. First, the soils in the study area are very impermeable to the flow of water. Permeability coefficients were 0.6 - 2.00 inches/hour for the Monona soils and 0.06 - 0.2 inches/hour for the Albaton soils. Second, most of the combined sewer system lies in the area where the Monona soils predominate; however, much of the sewer pipe is in the higher topographic area and would be above the water table. Sewers in the old Missouri River flood plain are in the Albaton Soils and although the water table is high, permeability is extremely low.

90. The depth to ground water was monitored during the last half of 1974. The depth to ground water ranged from 12 to 20 feet. The location of the piezometer tubes used to monitor the depth to ground water were located in north and south Omaha from 21st Street to 28th Street in Monona soils. At the four locations

monitored, the water was above the sewer, but these were the larger trunk sewers which would be deeper than much of the sewer system, especially the smaller laterals which make up most of the system. This further indicates that infiltration will be low.

91. The data presented in table C-2 verifies that the infiltration during dry-weather is low. It is negative in some areas which indicates that exfiltration or the loss of water from the sewer could exist.

92. Most of the measured flows in table C-2 were obtained from January to May 1974. Rainfall for the first 7 months of 1974 was lower than normal. Piezometer readings taken during this study indicate the ground water elevation follows the rainfall pattern. The above facts lead to the possibility that moisture content in the soil and ground water elevation were low during the period of measurement. Two additional facts would negate this suspicion. Rainfall during the last six months of 1973 was 6.20 inches above normal for Omaha, indicating that the soil moisture and ground water table should have been higher than normal at the beginning of the measurement period. Additional selected flows were measured in the summer of 1974. The summer measurements indicated a slight increase in flow over the spring measurements even though a drought period existed.

COST-EFFECTIVENESS ANALYSIS

93. In order to classify infiltration/inflow as excessive, the cost of treating the infiltration/inflow must be more than the cost of repairing or replacing the sewer which allows the infiltration/inflow to exist. For this analysis, a treatment cost of

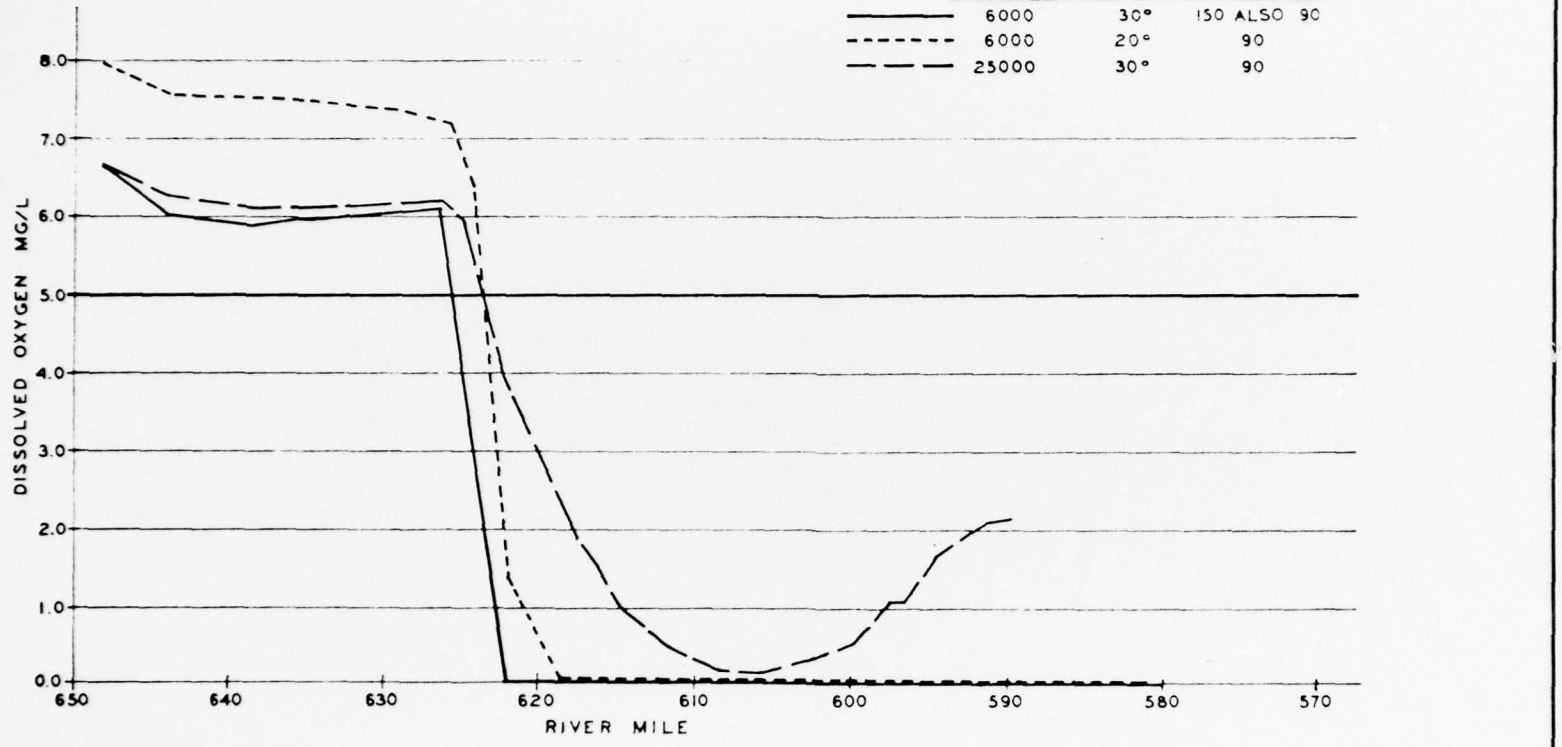
$150 per million gallons was used. This figure was obtained by using cost data in the Kirkham, Michael and Associates report "Post Primary Treatment Missouri River Plant - Omaha, Nebraska". Total costs were obtained by summing the total capital costs and the operating and maintenance costs for 1975 and 1995. Kirkham, Michael estimates that total capital costs in 1972 dollars is $25,240,600. Using the ENR index, this is adjusted to $33,770,600 in terms of February 1975 costs. Using a 20-year plant life and a 6 7/8-percent interest rate, the estimated yearly capital cost is $3,156,900. The 1975 and 1995 operating and maintenance costs are $2,110,000 and $2,517,700 respectively. The present worth of the total costs, capital plus operation and maintenance, is $56 million. Based on an average wastewater treatment rate of 52 MGD during the next 20 years, the present worth cost of treatment will be $150 per million gallons.

94. Table C-3 indicates that the average wet-weather infiltration/inflow to the Missouri River treatment plant is 3.814 MGD. The present worth cost to treat this flow over the next 20 years at $150 per million gallons is $4.2 million. Harza Engineering Company estimates that it would cost $27,000 per acre to separate the city of Omaha sewer system, which is the only way to reduce inflow into the combined sewer system. It is obvious that excessive infiltration/inflow does not exist.

95. There is a good possibility that the combined overflows will be placed under the National Pollutant Discharge Elimination System (NPDES) in the future. In this case, the entire wet-weather infiltration/inflow which is 18.114 MGD should be used in the analysis. The purpose of this infiltration/inflow analysis is to

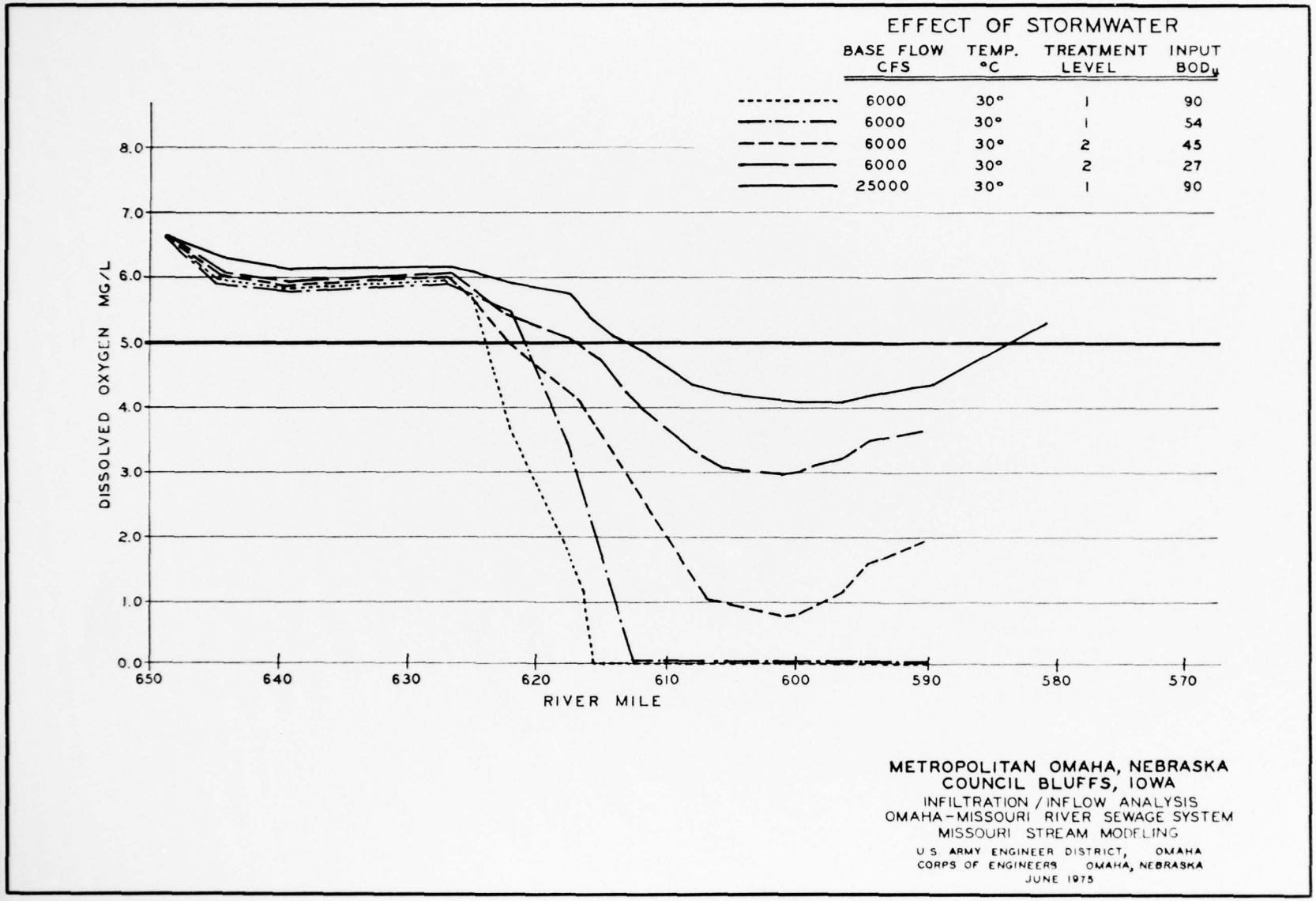
justify the sizing of secondary treatment facilities for the treatment of the wastewater that presently is being treated at the Missouri River treatment plant. Harza Engineering Company in their report, "Alternative Plans for Abatement of Pollution from Combined Sewer Overflows - Omaha, Nebraska", looked into plans for handling the present overflows to the river in facilities other than the presently planned Missouri River treatment plant. Plans developed indicate that treatment of the overflows through the planned secondary expansion would not be cost effective. A contact stabilization unit built adjacent to the Missouri River treatment plant would provide a lower unit cost per million gallons treated. Also, as demonstrated in figures C-6 and C-7, water quality modeling studies for the Missouri River indicate storage, sedimentation, and chlorination of the overflows may be sufficient to maintain water quality standards. This level of treatment is referred to as Level 1 stormwater treatment in the modeling studies. Microstraining is added to the above treatment to provide Level 2 stormwater treatment. Therefore, the design of the secondary treatment facilities at the Missouri River treatment plant will not be affected by any NPDES regulations on combined overflows.

96. Overall, excessive infiltration does not exist. The present-worth cost of treatment for the next 20 years of the 1.053 MGD of infiltration is only $1,153,000. The least-costly method of eliminating most of this infiltration would appear to be television monitoring and chemical grouting. Depending on the sewer conditions found during television monitoring, the chemical grouting process may or may not be recommended. A July 1972 article in Public Works magazine stated that television monitoring would cost 10 to 17.5 cents per lineal foot of sewer. The cost of



METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA
INFILTRATION / INFLOW ANALYSIS
OMAHA-MISSOURI RIVER SEWAGE SYSTEM
MISSOURI STREAM MODELING
U.S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA
JUNE 1975

VOLUME IV ANNEX E FIGURE C-6



METROPOLITAN OMAHA, NEBRASKA
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VOLUME IV ANNEX E FIGURE C-7

chemical grouting was estimated by a Waterloo, Iowa contractor to be $1.55 to $2.00 per foot of 8-inch clay pipe with 36-inch sections. The chemical grouting cost did not include the cost of the chemicals. The cost of the grouting would vary depending on sewer size and the condition of the sewer. For the purpose of this analysis, a cost of $2.00 per foot will be used. For $1,153,000, total infiltration from about 100 miles of sewer could be treated. This is less than 20 percent of the Omaha Missouri River sewer system. This is a 1-time repair cost, and this work may be required more than once in the next 20 years.

97. Even though the cost of eliminating excessive infiltration for the entire system is not feasible, the television monitoring and chemical grouting work should be considered for the three southernmost service areas: Greater Missouri Avenue, South Omaha, and Monroe Street. A total infiltration of 3.459 MGD is indicated for these three service areas. At $150 per million gallons, the present worth cost of wastewater treatment is $3,788,000. At $2.00 per foot, 360 miles of sewer could be repaired by chemical grouting for $3,802,000. This would mean that the 140 miles of sewer in the three service areas could be repaired at least twice within the next 20 years.

98. The above analysis indicates that some infiltration could be eliminated. The elimination of the infiltration indicated above will not affect the design of the secondary treatment facilities at the Missouri River treatment plant. In arriving at the design flow for the treatment plant, Kirkham-Michael and Associates made some assumptions on population growth and industrial growth for the area. If these assumptions turn out to be wrong,

then the design flow would be wrong. The elimination of 3 MGD of infiltration does not affect the design flow nearly as much as the uncertainties in population or industrial growth. Therefore, the design flow recommended by Kirkham-Michael and Associates should not be changed on the basis of the amount of infiltration.

EXFILTRATION

99. Table C-2 also presents some very unusual data, especially with respect to the amount of exfiltration that is indicated within the system. The possibility of exfiltration actually occurring is remote, consequently an attempt was made to find out why exfiltration is indicated. The following paragraphs outline some reasons for the final results shown.

100. Table C-2 indicates that there is a considerable amount of exfiltation occurring in the Bridge Street service area. The measured dry-weather flow is measured by a permanent recorder which has been reporting consistent flows for this area. The use of 50 gpcd as an average consumption figure might be high, but this figure would have to be dropped to 20 gpcd in order to indicate infiltration. Another possible explanation could be that not all of the sanitary flow is getting to the lift station. Also, all of the people in the area may not be served by the sewer system. One of these last two possibilities appears to be the best explanation.

101. An extraordinary amount of exfiltration is indicated for the Minne Lusa service area. The flow was recorded by a permanent recorder and was very consistent. Unless all of the flow is not getting to the interceptor, the accuracy of this device is suspect.

It appears that this permanent recorder is consistently recording low values for wastewater flow.

102. Table C-2 also indicates exfiltration for the combined Grace Street and Burt-Izard service areas. This flow is measured by a permanent recorder that is periodically checked. The figure arrived at for the amount of exfiltration can be changed to infiltration by lowering the per capita consumption figure to 30 gpcd. All of the wastewater flow may not be entering the Burt-Izard lift station and going to the Missouri River treatment plant. An in-depth analysis of the data and the method used to obtain the final data leads one to suspect the permanent recorder. This recorder measures all flow from the North Interceptor and Carter Lake-East Omaha as well as Burt-Izard and Grace Street. In order to obtain the flow for Burt-Izard and Grace Street, the total flow from the North Interceptor and Carter Lake-East Omaha is subtracted from the recorder readings at the Burt-Izard lift station. If the flow from Minne Lusa is more than reported, it would mean that the reported flow for Burt-Izard and Grace Street would be lower, and the per capita consumption figure would need to be lower yet in order to report any infiltration.

103. In general, the permanent recorder readings are suspect. In each area where exfiltration is indicated, permanent recorders report a flow that is considerably lower than the estimated wastewater flow. As indicated earlier, it is almost impossible for exfiltration to occur so that something is occurring that is not readily apparent. The values recorded by the permanent recorders seem to be the most logical reason for the results reported.

104. Even though the recorders are checked and found to be working properly, it appears that they are consistently inaccurate. The people who conducted the measurements of wastewater flow reported in this analysis feel that the permanent recorders in the Omaha-Missouri River sewer system record low values, especially after looking at table C-2. These same people feel confident that the weir measurements were accurate. They have more faith in these measurements that in the permanent recorder flow measurements. They feel that the measurements reflect their best effort.

105. In order to obtain a more reliable set of data, it is felt that a complete new set of permanent recorders should be installed. The existing collection and interceptor system lends itself to such a method of measurement. The prohibitive roadblock is money. Consequently, this analysis presents the best possible set of flow measurement data that can be obtained with the funds and equipment that are available.

106. This analysis has shown that excessive infiltration/inflow does not exist in the Omaha-Missouri River treatment plant presently. The cost of separating the system which is the only way to eliminate inflow in a combined system is so high that excessive infiltration/inflow will never exist.

SEWER MANAGEMENT IMPROVEMENTS

107. There is no reason to believe that infiltration shall increase appreciably in the future. The city of Omaha has a maintenance program that is presently keeping up with the repair of sewer failures. Omaha is presently initiating a program of compiling

data for computer storage of all information on the existing sewer system. This program, once it is in operation, will be able to print out data on the location, size, and condition of individual components within the sewer system. This will help the city in its maintenance program by pointing out the problem areas for repair or replacement. Whenever possible, the city of Omaha is separating the sewers especially where large sections of sewer need work. In general, the city of Omaha is in the process of setting up a maintenance program that should keep pace with the gradual deterioration of the sewer system.

108. The city is also making plans to eliminate the discharges of raw dry-weather flows due to mechanical failures at the grit removal facilities and lift stations. In order to do so, the city plans to put in parallel facilities at the problem locations. The city of Omaha Public Works Department estimates that it will cost approximately $5.5 million to do so. Implementation of these plans would be extremely cost-effective in reducing dry-weather bypass flows to the Missouri River.

Conclusions and Recommendations

109. Based on a cost-effectiveness analysis of the infiltration/inflow that is presently being treated at the Omaha-Missouri River treatment plant, the following conclusions can be made:

Excessive infiltration/inflow is not present in the Omaha-Missouri River treatment plant flow.

It is not necessary to proceed with a sewer system evaluation as described in "Guidelines for Control of Infiltration/Inflow in Sewer Systems".

110. The present sewer collection system being a combined system carries a flow that is greater than can be handled by the present interceptor system and sewage treatment plant. These excessive flows are presently being discharged to the Missouri River. This analysis did not include these flows in the cost-effectiveness analysis since alternative plans have been presented in a report by Harza Engineering Company for treating these wastes in another system.

111. Based on the findings of this analysis and on the report by Harza Engineering Company on the treatment of the combined sewer overflows to the Missouri River, it is recommended that the Environmental Protection Agency authorize the city of Omaha to complete plans for the secondary treatment facilities at the Missouri River treatment plant and to proceed with plans to construct these facilities.

112. It is recommended further that dual grit removal facilities be installed within the system particularly at the present Burt-Izard and Leavenworth stations. Installation of the dual grit removal facilities is vital to the efficient operation of the city's sewer system and should be given high priority.

113. It is also recommended that the city of Omaha investigate the possibility of elimination of most of the infiltration in the Greater Missouri Avenue, South Omaha, and Monroe Street service areas.